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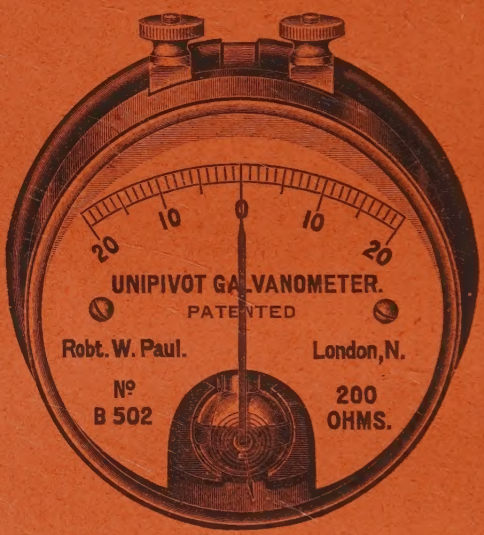

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SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JUNE 1913.

GENERAL PHYSICS.

901. *Apparatus for Measurement of Distance.* **E. Hammer.** (Zeitschr. Instrumentenk. 33. pp. 52–59, Feb., 1913.)—Describes an apparatus similar to a theodolite, but having two telescopes, one above the other, the axes about which the telescopes turn being slightly inclined to one another. The instrument was designed by J. Zwicky for distance measurements. For details and method of use the original paper should be consulted. A. W.

902. *Simple Method for determining the Densities of Powdered Minerals.* **M. Billy.** (Comptes Rendus, 156. pp. 1065–1067, April 7, 1913.)—In measuring the density of a powdered metal, etc., error is introduced owing to the presence of numberless small gaseous envelopes surrounding the solid particles. In order to avoid this, the author replaces the air held by the powder by carbon dioxide and weighs the substance, not in water, but in approximately normal potassium hydroxide solution, which has been previously boiled. The density of the alkaline solution alone is determined in the same way, the pyknometer being filled with carbon dioxide before the liquid is introduced. A special apparatus has been designed to facilitate these operations. The method was tested by the examination of powdered glass, the density of which had been measured prior to powdering. Whereas other methods give results accurate to about 1 part in 300, the author's method showed an accuracy of the same order as that of the balance employed, namely, 1 in 3000. It would therefore seem advisable to powder all solids before measuring their density, so that the absence of enclosed bubbles or fissures may be ensured. T. H. P.

903. *Law of Plastic Flow.* **C. E. Larard.** (Phys. Soc., Proc. 25. pp. 83–92; Discussion, pp. 92–94, Feb. 15, 1913.)—Strain measurements in the twisting to destruction at a uniform angular velocity of 0·1145 degree per sec. of a cylindrical bar of 0·32 % carbon annealed steel gave the following results. The torque had to be increased at a rate varying inversely as the time since the commencement of the test. In the equation $t + t_0 = ae^{bT}\ t$ is time, and T is torque. t_0 is a small time constant, the value found being about 6 secs.,

which is not very material, as the total time of test was 42 mins. a is 8·23 and b is 1/30. There is elastic strain proportional to the torque, up to the maximum. At very low and very high speeds of twisting the yield-point is suppressed. The yield-point in the ordinary case is raised by strain followed by slight warming. In the *discussion*, **R. A. Hadfield** said that records of the passage of a projectile through a plate showed that even at these high speeds of straining steel behaved much the same as in ordinary tests. **R. Appleyard** criticised the constants in the author's equation, and suggested some revised values. F. R.

904. *Anomalous Variation of the Rigidity of Phosphor-bronze.* **H. Pealing.** (Phil. Mag. 25. pp. 418–427, March, 1913.)—The modulus of rigidity of phosphor-bronze strips, as determined from torsional oscillation experiments is found to be less at light loads than at heavy, the variation being greatest in thin strips, very small in thick strips, and entirely absent in wire. With lapse of time under steady load the discrepancy tends to disappear, the rigidity levelling up to a value above the initial maximum. Amplitude and damping of the swing have no effect on the rigidity. Experiment disproves the suggestion that the strips have any bifilar properties whereby the restoring couple would vary as the weight supported. It was concluded that initial kinks in the strip had a negligible influence on rigidity, apparent or real. It was found that annealing the strips made them softer, but the restoring couple was substantially increased, being the same at all loads. This result supports the conclusion that the variation in rigidity is due to initial overstraining received in manufacture. This overstrain in rolling is located on the surfaces, and it was sought to counteract it by imposing excessive skin stresses by winding the strip round a narrow cylinder. On the spiral strip thus obtained being straightened out its rigidity was found to be uniform, being unchanged at high loads, and greatly increased at low loads. The effect was permanent, the conclusion being that the overstraining in manufacture has been neutralised by that caused in the test. E. J. S.

905. *Resilience.* (Rev. de Métallurgie, 9. pp. 1174–1181, Dec., 1912.)—An apparatus has been designed in the Metal-testing Department of the Cie. des Chemins de fer Paris-Lyon-Mediteranée for making shock tests on notched bars and for measuring the energy left in the tup after fracture of the specimen. Experiments made with this apparatus show that the resilience is always less when the tup is caused to fall from a height just sufficient to break the specimen than when it falls from a greater height. The resilience is inversely proportional to the weight of the tup, so that the product of the height and resilience is constant. With equal sections the angle of the notch has a considerable influence on the resilience of a metal. F. C. A. H. L.

906. *Effects of Holes and Semicircular Notches on the Distribution of Stress in Tension Members.* **E. G. Coker.** (Phys. Soc., Proc. 25. pp. 95–105, Feb. 15, 1913.)—For a tie with a circular hole the values of $(p_x - p_y)$, p_x and p_y being the principal stresses, obtained optically agree fairly with theory if the diam. is not over $\frac{1}{4}$ the width of plate. A formula obtained for the max. stress is $p_{\max.} = 6c^3/(2c^3 + 2c^2 + c + 1)p_{\text{mean}}$, where c = ratio of width of tie to diam. of hole. If c is much over unity $p_{\max.} = (3c/c + 1)p^{\text{mean}}$. With 2 semicircular notches symmetrical with the centre-line and on the cross-section Leon gives the approximate solution $p_x = \frac{1}{2}p(2 + a^2/r^2 + a^4/r^4)$ and $p_y = \frac{1}{2}p(a^2/r^2 - a^4/r^4)$. Determination of $p_x - p_y$ shows that the max. values

agree with the formula for notches with max. radius about $\frac{1}{4}$ of width of member. A proposed formula for determining the max. stress is—

$$p_{max.} = 12c^3/(6c^3 + 4c^2 + c + 1)p_{mean}.$$

[See Abstract No. 296 (1911).] E. J. S.

907. *Thermoelectric Indication of Fatigue as a Method of Testing.* **T. R. Lawson** and **J. A. Capp**. (Rev. de Métallurgie, 10. pp. 174–198, Jan., 1913.)—The determination of the elastic limit by means of a thermo-couple has attracted the attention of several investigators, and it has been shown that below the elastic limit, a bar of metal in tension absorbs heat, while above the elastic limit heat is generated by the friction of the particles during gliding over each other. It has also been stated that the thermal limit of proportionality is slightly lower than the true limit, and that below the thermal limit the variation of temperature is directly proportional to the effort. With the object of applying the phenomenon as a method of determining the elastic limit of small and other samples which do not permit of the application of the ordinary methods, the authors have made tests on various steels, cast-iron, and various copper alloys. Tests were made in an ordinary tensile testing machine, the stretch being observed by an extensometer, and the temperature variation by means of a copper-constantan couple pressed into contact with the specimen by a rubber band, and connected to a sensitive galvanometer. Examination of the large number of curves reproduced shows that in every case there is a discontinuity in the temperature curve in the region of the yield-point, but that generally speaking the thermal limit is somewhat higher than the true yield-point. Below the yield-point some of the thermal curves are inexplicably irregular, but in no case are they represented by straight lines. The investigation is not regarded as complete, but is to be continued by the authors.

F. C. A. H. L.

908. *A.E.F. Recommendations for Units and Symbols.* (Elektrotechn. Zeitschr. 34. pp. 308–310, March 13, 1913. Deutsch. Phys. Gesell., Verh. 15. 5. pp. 143–150, March 15, 1913.)—Contains amendments to Section VII of the Committee's Report [Abstract No. 649B (1910)]; part A remains unaltered. A revised list of units, abbreviations, and symbols is given, and is followed by a report by K. Scheel and K. Strecker. In the mensuration section, it is suggested that $\lambda = 0{\cdot}001$ millilitre ($= 0{\cdot}001$ c.cm.). A symbol for 100 kg. is needed; dz. (Doppelzentner), is unsatisfactory; q. (Quintal), is much used in France and Italy, but is not suitable for German or English use; and hkg. (hecto-kg.) is not to be recommended, but there appears no serious objection to dt. (dezitonne). By γ is to be understood $0{\cdot}001$ mgm. The abbreviations st., mn., sk., have not received approbation. St. cannot become an international abbreviation (for hour), and yields inconvenient compound abbreviations. It is recommended that the same abbreviation be used for time periods and time instants, the two cases being distinguished by writing the symbols on and above the line respectively: *h.* is to be used for hour and *s.* for second; *m.* may be used for minute where there is no doubt as to its significance. It is not wise to use the same signs for time minutes and seconds as for angular minutes and seconds and the use of simple figures, (*e.g.* 4.50.10 for 4h. 50m. 10s.), may lead to misinterpretation, though it is permissible in time-tables, etc. The legal and international *gramme* cannot

be renamed, hence, to distinguish between mass and force units, the latter must be given a distinctive name. Budde has recommended the term *bar*. In 1900, the Physical Congress (Paris) resolved to denote unit pressure on unit area by *barye*; about the same time, Bjerknes called 10^6 dynes/cm.^{2} a *bar*. The new unit is much used in oceanography and meteorology. The International Aero Commission (May, 1912) resolved to adopt this unit. Further, T. W. Richards (1904) recommended that 1 dyne per cm.^{2} be termed a *bar*, and the latter name has been used in various scientific works. Under these circumstances it is doubtful whether *bar* can safely be used as the name of the force unit, but this course is provisionally adopted. 1 *kilobar* = weight of 1 kg.; 1 *megabar* = weight of 1 metric ton (*tonne*). It is expected that the distinctive nomenclature for the weight of the gramme, etc., will avoid innumerable difficulties. The *dyne* is inconveniently small for use in technical calculations, and the *megadyne* is not large enough in many cases. Grübler suggests that the force which accelerates 1 tonne mass at 1 m./sec.^{2} be termed 1 *vis* (v.); this unit = 10^8 dynes and = weight of 100 kg. (approx.) $\simeq$ 102 kb. The corresponding work unit is the *vismetre* (vm.); and the power unit, the *vismetre per sec.* which is familiar under the name kilowatt. The new force unit fits well in the electrotechnical units derived from the absolute mass system. Grube wishes to distinguish between static and dynamic forces, holding that the two are not of like dimensions; the present recommendations do not support this distinction, but regard 1 v. $\simeq$ 102 kb. as a correct equation. Taking the *bar* as the technical force unit, the unit of work = 1 kilobar-metre = 1 kbm.: (mkb., though uniform with m.kg., might be read as 10^{-3} kb.). Stress units are altered in accordance with the altered force unit; instead of kb. mm.$^{-2}$ is recommended kb./mm.^{2}, this being equally correct and easier to write, read and interpret. The distinction between Cal. and cal. is insufficient, and it is recommended that the gramme-calorie be represented by cal. and the kg.-calorie by kcal. Reasons for not calling the calorie the Wärmeeinheit (heat unit) are given in the earlier treatment of Section VII (*loc. cit.*). Light units have not roused much interest; one suggestion had been that Lux be not abbreviated. The ohm is to be denoted by $\not\Omega$, the forked arrow indicating the electrical nature of the unit. For ampere-turns use Aw; watt-hour, Wh; ampere-hour, Ah. R. E. N.

909. *Four-dimensional Theory of Gravitation.* **J. Ishiwara.** (Tôhoku Math. Journ. 3. pp. 9–14, March, 1913.)—Gives a four-dimensional theory of gravitation based upon the electromagnetic theory of Minkowski and Sommerfeld [see Abstracts Nos. 1468 (1911) 785 (1912)]. The electromagnetic equations differ from those of Maxwell in that the velocity of light is not a constant, but a function of the space-time co-ordinates. The author arrives at a formula for the propagation of transverse electromagnetic waves from which the curvature of a ray of light in the gravitational field may be calculated. E. E. F.

910. *Influence of the Support on Pendulum Observations.* **E. Esclangon.** (Comptes Rendus, 156. pp. 1005–1008, March 31, 1913.)—Important corrections have to be introduced in pendulum observations to account for the influence of the support. The author discusses the correction formula of Peirce and Cellerier, $\alpha T = -\pi\sqrt{(\lambda/g)}\,.\,1/k\,.\,Mgh/2\lambda^2$, where M is the mass of the pendulum, λ the length of the corresponding simple pendulum, h the distance between the centre of gravity and the axis of suspension, and k the statical coefficient of flexure. He points out that Plantamour has distin-

guished two coefficients of flexure, viz., statical and dynamical, and since experiment has shown a great difference to exist between the two values there arises the question of which coefficient to adopt in the formula. Dessorges finds the statical flexure to be indicated by experiment. Now Peirce and Cellerier have introduced into the formula neither the mass of the support nor the possibility of phase between the two oscillating movements of support and pendulum. The author endeavours to establish that it is the coefficient of statical friction which should enter into the formula, and also that the necessary corrections depend neither on the mass of the support nor the internal friction which tends to stop the oscillations. The amplitude only is found to be affected by friction, and this diminishes slowly while remaining independent of the inertia mass of the support. H. H. Ho.

911. *Zone of Formation of Alternate Vortices behind an Obstacle.* **H. Bénard.** (Comptes Rendus, 156. pp. 1003–1005, March 31, 1913.)—The author has previously proved the formation of two parallel sets of gyration-centres, equidistant and alternate, on the surface of a liquid parted by a vertical prismatic object whose speed is uniform and parallel to its plane of symmetry. Also he has described a kinematographic method for demonstrating the laws of this periodicity. The present paper contains a very detailed description of the method accompanied by illustrations. In the latter a central dissymmetrical space is shown in the rear of the obstacle, constituting the vibration zone where the alternate vortices are formed. At two instants separated by a half-period the appearance of the zone is exactly symmetrical with regard to the plane of symmetry of the obstacle. The cases for speeds ranging from low to high are treated, and the conclusions drawn from each. H. H. Ho.

912. *Existence of a Superficial Viscosity in the Thin Transition Layer Separating one Liquid from another Contiguous Fluid.* **J. Boussinesq.** (Comptes Rendus, 156. pp. 983–989, March 31, 1913.)—Where two liquids are in contact, or a liquid and a gas, there exists a thin superficial layer of separation which is not isotropic to the state of equilibrium like the neighbouring matter. Since a fluid is characterised by the property of never ceasing to return to its equality of constitution in every direction when deformed by external movement, and also when thermally disturbed, tends by an evolution of molecular groupings to equalise, more or less rapidly, the average distance of these apart, so will the same evolution take place in the transition layer separating two fluids to bring about complete isotropy. The author explains the enormous values per unit area of the superficial tension, by a general discussion of the tensions and pressures in the fluid. After considering the statical case, the author takes up the problem of fluids in a state of motion, pointing out that a certain interval of time is required, short for slightly viscous fluids and larger for others, before the internal configuration becomes that of final equilibrium. The nature of viscosity is thus introduced, and, after investigation, is applied to the case of the transition layer. The conclusion is drawn that the superficial tensions applied to a normal section of a film will always be tangential with respect to its plane, and that they will depend linearly upon the rates of deformation. It is necessary to know the rates of dilatation of two rectangular rows of molecules in a film and their rate of mutual sliding. The author then draws the conclusion that there will be two coefficients of superficial viscosity. Observations of capillarity have only been made by physicists under equilibrium conditions, and the author

concludes that that is the reason why the idea of viscous forces has not been introduced. The author points out that these viscous forces are as necessary for the study of the superficial layer of a liquid as for the hydrodynamics of fluids in bulk. H. H. Ho.

913. *Application of Formulæ for Superficial Viscosity to a Drop falling within a Fluid of Lower Density.* **J. Boussinesq.** (Comptes Rendus, 156. pp. 1035–1040, April 7, 1913.)—The results arrived at in a previous paper by the author [see preceding Abstract] are applied to the case of a drop of fluid (of spherical shape) falling slowly, with a motion which has become uniform, within a fluid at rest of less specific gravity. Suitable axes of co-ordinates are chosen and the drop is referred to these. Only the layer of separation is considered, which, owing to the slow rate of movement, may be assumed to possess a permanently spherical shape since the equations of motion remain linear owing to the fact that squares of velocities may be neglected. The various dynamic equations are then derived and the nature of each discussed. H. H. Ho.

914. *Viscosity of Air.* **L. Gilchrist.** (Phys. Zeitschr. 14. pp. 160–165, Feb. 15, 1913. Phys. Rev. 1. Ser. 2. pp. 124–140, Feb., 1913.)—According to Millikan [Abstract No. 943 (1911) the only limit to the accuracy with which the electronic charge can be determined is set by the difficulty of determining the absolute viscosity of air. The method of direct deflection used by the author reduces the error to 0·2 per cent. In this method an outer cylinder is kept in constant rotation, while an inner cylinder, attached to a bifilar suspension, measures the viscosity of the gas by a constant deflection. The mean value obtained for the viscosity at 20·2° is 1812·2 with a total probable error not exceeding 0·2 %. The presence of water-vapour up to 60 % of the saturation value at 20° has no effect on the viscosity, and at saturation the effect is an increase of not more than 0·3 %. E. E. F.

915. *Capillary Phenomena in Gases.* **G. Reboul.** (Comptes Rendus, 156. pp. 688–691, March 3, 1913.)—The chemical action of a gas on a solid is greatest at the points of max. curvature of the latter [see Abstract No. 729 (1913)]. To study the matter quantitatively, the author exposed a series of copper cylinders with diameters ranging from 0·23 to 1·5 mm. for 25 minutes to gas emitted by vulcanised rubber at a pressure of 1·6 mm., and estimated the thickness of the oxidised layer by the colour of the surface film. The results are the same as if there were an excess of pressure proportional to the curvature of the surface separating the solid from the gas. This leads to a formula similar to that given by Laplace for capillary force. This capillary action between solids and gases is paralleled by the electro-capillary force between mercury and gas discovered by the same author. E. E. F.

916. *Aerodynamics.* **A. Lechner.** (Phys. Zeitschr. 14. pp. 210–212, March 1, 1913.)—Determines both theoretically and experimentally the "phygoid" or trajectory of a flying model for the case when it moves in a liquid. The phygoid theory is directly applicable to liquids if the laws of resistance are the same as in air. The paths can either be circles or waves, according to the initial velocity and direction, and in the case of instability "tumbling" curves will be obtained. This was verified by means of flying models of thin sheet metal cut out in the rough outline of birds, and tipped with lead. These were released or projected in water. E. E. F.

917. *Philosophical Aspects of Relativity.* **R. D. Carmichael.** (Phys. Rev. 1. Ser. 2. pp. 179–197, March, 1913.)—A clear *résumé* of the postulates of relativity and their logical consequences, together with the experimental basis upon which the theory rests; the whole being treated from the philosophical standpoint. Some extremely suggestive questions are proposed, such as: Is there any *absolute length* assignable to a given material body? Is there any absolute criterion of the simultaneity of events happening at different places? [See Abstracts Nos. 19 and 755 (1913).] E. H. B.

918. *Universal Measuring Apparatus for Photographic Survey and Micrometric Measurement of Capillary Waves.* **L. Grunmach.** (Deutsch. Phys. Gesell., Verh. 15. 5. pp. 134–139, March 15, 1913.)—A full description of the apparatus, with photographs, is given. There are also three photographs of the waves obtained with mercury, water, and alcohol, and one showing the corresponding known distance between the points of the tuning-fork. A. E. G.

919. *Substitution of the Theodolite for the Perspective Nephoscope.* **A. Lo Surdo.** (N. Cimento, 5. Ser. 6. pp. 97–100, Feb., 1913.)—The author describes how the data previously shown [Abstract No. 570 (1913)] to be obtainable with the perspective nephoscope, can be more conveniently obtained by the use of a theodolite. W. H. Si.

920. *Ponderomotive Forces in Relativity Theory.* **M. Laue.** (Phys. Zeitschr. 14. p. 210, March 1, 1913.)—Explains a discrepancy between his own and Planck's transformation formulæ for ponderomotor forces, worked out by Abraham's method [Abstract No. 1197 (1910)]. E. E. F.

921. *P. Appell's Equations and Continuous Media.* **E. Guillaume.** (Comptes Rendus, 156. pp. 875–879, March 17, 1913.)—Appell's dynamical equations are here extended to continuous media and also to electrons. E. H. B.

922. *Theory of the Phenomenon known as "Water-hammer."* **L. Allievi.** (Atti dell' Assoc. Elettr. Ital. 17. pp. 127–150, Feb. 28, 1913.)

923. *Ocean Waves, Sea-beaches, and Sandbanks.* **V. Cornish.** (Soc. Arts, Journ. 60. pp. 1105–1110, Nov. 1, and pp. 1121–1126, Nov. 8, 1912. Cantor Lectures.)—A table is included which gives the observed dimensions of waves as compared with those calculated by the general formula. The observed are in all cases somewhat lower than the calculated values. L. H. W.

924. *Errors of Meteorological Observations having a Psychological Origin.* **G. Hellmann.** (Preuss. Akad. Wiss. Berlin, Ber. 14. pp. 283–294, 1913.)—Of these some of the best known are mistakes of 5° and 10° in readings of temperature. Others arise from the practice of reading temperature to tenths of a degree, the thermometers being graduated either to fifths, halves, or whole degrees only. For thermometers divided to fifths of a degree the frequency of occurrence of the even tenths, coinciding with the graduation marks on the thermometer, is usually appreciably greater than that of the odd tenths, the reason being that the presence of the marks on consecutive even tenths favours a throw up or down to one of those values, or a reading falling between them, rather than a throw to the intervening odd tenth.

The phenomenon is more pronounced at some stations than at others. For thermometers graduated in half degrees the frequency curves of readings of the different tenths of a degree fall in three classes, of which the first has maxima at 0 and 5 tenths, the second show minima at the same places, and the third has four maxima at 1, 4, 6, and 9 tenths. The corresponding frequency curves for thermometers graduated in whole degrees suggests that the observer really reads to quarters and not to tenths, there being 4 maxima. This type of error does not affect mean values. The results show that no great advantage results from dividing the degree into halves to assist the eye in estimating tenths, but division into fifths does result in more accurate observations such as are required for measurements of humidity. R. C.

925. *Standard Deviation, Asymmetry, and Correlation, with an Application to Variations of Pressure in Iceland, the Azores, and Europe.* **W. Köppen.** (Meteorolog. Zeitschr. 30. pp. 113–125, March, 1913.)—Some of the terms employed in the statistical methods which are in frequent use in this country, but appear to be almost unknown in German-speaking countries, are explained, and methods of computing correlation coefficients are described. An application to winter mean pressures over Iceland, the Azores, and Europe, from observations extending over the years 1865 to 1900 gives the following values for the correlation coefficients:—

Iceland—Azores	−0·52
Iceland—Vienna	−0·42
Vienna—Azores	+0·16
Berlin—Vienna	+0·90

R. C.

926. *Antarctic Barometric Pressure.* **G. C. Simpson.** (Nature, 91. p. 135, April 10, 1913.)—The author calls attention to a very large rise of pressure which occurred in antarctic regions between Oct. and Nov., 1911, as shown by the records at the three stations Framheim (Norwegian winter quarters), Cape Evans, and Cape Adare. The mean pressure for Nov. exceeded that for Oct. by 0·87 in., 0·81 in., and 0·80 in. at the three stations respectively. This rise from one month to the next is considered to be unprecedented. J. S. Di.

927. *Rainfall over Long Periods.* **A. E. Douglass.** (Science, 37. p. 33, Jan. 3, 1913. Paper read before the Astronom. and Astrophys. Soc. of America.)—From a test extending over 43 years it is found that the radial thickness of the rings of the yellow pine of Northern Arizona gives a measure of the rainfall in the vicinity with an average accuracy of over 70 %. Variations of 21 years and 11·4 years were found. C. P. B.

928. *Rainfall measured along the Panama Canal.* (Meteorolog. Zeitschr. 30. p. 157, March, 1913. Report of Isthmian Canal Commission.)—A marked seasonal variation occurs, with minimum in Feb. or March (from 4 mm. to 92 mm. in a month), and double maximum in May–July (227 mm. to 497 mm.) and Oct.–Nov. (278 to 752 mm.). The rainfall along the Pacific coast is about half that measured on the Atlantic side, which varies from about 3300 to 4300 mm. in the year. At one station, so much as 23 mm. (0·9 in.) fell in 5 minutes. R. C.

929. *On the Coefficients and Exponent of the Radiation Equation, $K_{10} = cT^{a}_{10}$ in the Earth's Atmosphere.* **F. H. Bigelow.** (Amer. Journ. Sci. 35. pp. 254–

266, March, 1913.)—A largely theoretical determination of the values of c and a in the above radiation equation, the necessary data being taken from certain published upper-air records in different parts of the world. The value of the exponent a is found to vary with latitude and height over a range of from 3·75 to 3·86. It is large at the surface and decreases with increase of height. J. S. Di.

930. *Sky Radiation and the Isothermal Layer.* **F. W. Very.** (Science, 37. p. 37, Jan. 3, 1913. Paper read before the Astronom. and Astrophys. Soc. of America. Amer. Journ. Sci. 35. pp. 369–388, April, 1913.)—Water-vapour is found at an altitude of 30 km. in the atmosphere, and as temperature inversion is intimately associated with excessive amounts of aqueous vapour it is possible that the region of permanent temperature inversion, the isothermal layer, may be due to this factor. Even in the coldest and driest weather, the sky temperature has never been found lower than that of the isothermal layer, which behaves like a nearly black body of approximate temperature 218° abs. C. P. B.

931. *Thermodynamics of the Earth's Non-adiabatic Atmosphere.* **F. H. Bigelow.** (Amer. Journ. Sci. 34. pp. 515–532, Dec., 1912.)

932. *Note on Atmospheric Radiation.* **F. W. Very.** (Amer. Journ. Sci. 34. pp. 533–538, Dec., 1912.)—The author discusses the radiation taking place in the different layers of the atmosphere with special reference to some of Bigelow's recent work on the subject [see preceding Abstract]. The paper is supplementary to this paper of Bigelow's. J. S. Di.

933. *On the Origin of Falls of Dust in the Ocean West of the Sahara.* **G. Hellmann.** (Preuss. Akad. Wiss. Berlin, Ber. 14. pp. 272–282, 1913.)—An African origin of the red dust which frequently falls in the ocean between the Canary Isles and the Cape Verde Isles had been denied by Ehrenberg, who stated that there is no trade wind in the interior of Africa, and that there are no areas covered with red dust. The author shows that both statements are not in accord with observation. R. C.

934. *Temperatures of Subterranean Waters.* **E. A. Martel.** (Comptes Rendus, 156. pp. 741–742, March 3, 1913.)—On former occasions the author has made contributions to this subject and has drawn attention to the fact that there are seasonal variations of temperature much more considerable than had been previously supposed to be the case. The opinion that these underground waters have a very constant temperature corresponding to the mean annual temperature of the district where they are found, has been almost regarded as a meteorological law. Examination of the reports of subterranean water supplies obtained under the direction of Dabat, "directeur général des Eaux et Forêts," has furnished the material for completely exploding this antiquated idea. Thus in the Gironde a number of springs show variations of from 6° to 14° according to the time of year; in the Nord department these seasonal deviations run from 3° to 7° (6° or 8° to 12° or 13° C.), whilst in the districts of Douai and Cambrai many small springs not only vary in temperature but show a remarkable inferiority of 6° to 8° below the local mean annual temperature. Other remarkable results are quoted by the author. He arrives at the true meteorological and hygienic law that "the temperatures and delivery vary equally, and the more variable these are the

more uncertain is their purity, for their filtering power is a function of their speed of transmission." This combined with the results of geological observation is of the greatest importance from the point of view of sources of drinkable water supply. The constancy of temperature exists only in the continuous sources from sand and similar material, artesian supplies at great depths slowly and regularly maintained. F. W. H.

935. *Solar Radiation during Eclipse, April* 17, 1912. **W. Gorcynski.** (Comptes Rendus de la Soc. Scientifique, Warsaw. Nature, 91. p. 67, March 20, 1913. Abstract.)—The diminution of the solar radiation began half an hour before the eclipse, and remained below the normal for the data for nearly the same time after. The drop in temperature was between 2° and 3° C. C. P. B.

936. *Radial Motion in Sun-spots.* **C. E. St. John.** (Science, 37. p. 28, Jan. 3, 1913. Paper read before the Astronom. and Astrophys. Soc. of America.)—Three regions are indicated in the solar atmosphere surrounding spots with the following characteristics: (1) The upper chromosphere, motion inward, shown by the lines H and K of calcium, and H_α of hydrogen. (2) An intermediate region, shown by the D lines of sodium, *b* lines of magnesium, and the strong aluminium and iron lines, motion inward generally prevailing. (3) A lower region of outward motion, velocity increasing with lower levels. C. P. B.

937. *Pressure in the Solar Atmosphere.* **C. E. St. John.** (Science, 37. p. 28, Jan. 3, 1913. Paper read before the Astronom. and Astrophys. Soc. of America.)—An investigation involving the comparison of arc and solar spectra of iron is being carried out at the Mount Wilson Solar Observatory with the 150 ft. Tower telescope. The preliminary results show that the solar lines of iron classified in accordance with their displacement in the solar spectrum fall into the classes suggested by Gale and Adams in their study of pressure-shift under laboratory conditions, and indicate pressures in the solar atmosphere varying from 0·7 to 6·5 terrestrial atmospheres for the different groups. C. P. B.

938. *Atmospheric Transmission of Solar Radiation.* **F. W. Very.** (Science, 37. pp. 36–37, Jan. 3, 1913. Paper read before the Astronom. and Astrophys. Soc. of America. Astrophys. Journ. 37. pp. 31–47, Jan., 1913.)—The coefficient of atmospheric transmission of solar radiations on a given day is variable because of the variation of atmospheric extinction with zenith distance, and because their absorbent quality changes in the middle of the day, especially if much moisture is present. A criterion of the accuracy attainable in different observations is illustrated in the discussion of results by Savélief and Kimball. C. P. B.

939. *Irregularities in Atmospheric Refraction.* **F. Schlesinger.** (Science, 37. pp. 25–26, Jan. 3, 1913. Paper read before the Astronom. and Astrophys. Soc. of America.)—The investigation was suggested by the recent work of Nusl and Fric at Prague, who found irregularities in refraction having a period of about one minute, with considerable amplitude. A number of photographs were taken by Slocum at the Yerkes Observatory with the 40-in. refractor,

showing the trails of the Pleiades stars. These trails were measured at Allegheny, and it was found that the irregular refraction was undoubtedly indicated, the results tending strongly to confirm the deductions of Nusl and Fric. C. P. B.

940. *Absorbing Medium in Space.* **E. S. King.** (Science, 37. p. 32, Jan. 3, 1913. Paper read before the Astronom. and Astrophys. Soc. of America.)—Evidence of the absorption of light in space is instanced, extending to 0·0377 mag. for the photographic rays, and 0·0184 mag. for the visual rays, while traversing the unit of distance, 32·6 light years. Other work extended the inquiry to a greater number of stars, and the former results were confirmed, suggesting the presence of some factor making the more distant stars appear redder. C. P. B.

941. *Possible Lunar Changes.* **P. Stoïan.** (L'Astronomie, Jan., 1913. Nature, 90. p. 629, Feb. 6, 1913. Abstract.)—A small hill to the north of the line joining the lunar features Thebit and Birt has been suspected of undergoing changes of size and shape. C. P. B.

942. *Scale of the Durchmusterung.* **E. C. Pickering.** (Science, 37. p. 26, Jan. 3, 1913. Paper read before the Astronom. and Astrophys. Soc. of America.)—In *Harvard Annals,* 23. the deviations, from the photometric scales, of the magnitudes 9·0 and brighter are discussed. Volumes 70 and 74 include a similar study of the fainter stars, and of those in the Cordoba Durchmusterung. The deviations of the Cape Durchmusterung magnitudes from the photometric magnitudes are reduced one-half by grouping stars on the same plate and applying a correction for the class of spectrum. C. P. B.

943. *Stellar Spectra with Objective Prism.* **E. C. Pickering.** (Amer. Philosoph. Soc., Proc. 51. pp. 564–567, Oct.–Nov., 1912.)—The principal advantages of the objective-prism method for stellar spectrum photography are (1) the small loss of light; (2) the large number of stars which may be photographed simultaneously; (3) that it is not necessary to follow, as when photographing star charts. With the Harvard 8-in. doublet as many as three or four hundred spectra are often obtained on a single plate, including all stars of the ninth magnitude and brighter, in a region ten degrees square. A comparison spectrum cannot be used with an objective prism, and it is therefore difficult to obtain absolute wave-lengths, which are needed to determine the motion of stars in the line of sight. Various plans have been devised to overcome these drawbacks. The latest investigation undertaken at the Harvard College Observatory is the classification of 100,000 stellar spectra taken with the 8-in. doublets. C. P. B.

944. *Systematic Motions of the Stars.* **B. Boss.** (Science, 37. p. 27, Jan. 3, 1913. Paper read before the Astronom. and Astrophys. Soc. of America.)—Analysis of the distribution of stars shows the prevalence of B-type stars in the galactic plane, a similar grouping for the A-type stars, while the stars with more advanced spectra appear to be distributed more at random. Considered in relation with the star motions this suggests that a state of approximately random motions must eventually prevail throughout the universe. C. P. B.

945. *Magnitude Scale of Polar Sequence.* **F. H. Seares.** (Science, 37. pp. 34–35, Jan. 3, 1913. Paper read before the Astronom. and Astrophys. Soc.

of America.)—With the object of determining absolute star magnitudes a series of magnitude determinations have been made of the stars in the polar sequence. The mean deviations of groups of stars from results obtained at Mount Wilson and Harvard are tabulated, showing satisfactory agreement down to magnitude 15·5 ; beyond this limit there is a divergence as yet unexplained. C. P. B.

946. *Relation between Spectrum and Colour Index of Stars.* **J. A. Parkhurst.** (Science, 37. pp. 30–31, Jan. 3, 1913. Paper read before the Astronom. and Astrophys. Soc. of America.)—Revised data from a catalogue of magnitudes and spectra of northern stars furnishes material for a curve showing the relation between spectrum and colour index. The range in magnitudes of the stars used is between 4 and 9. Plotting the colour index as abscissæ and the spectral class as ordinates, a straight line is found to fit the points better than any simple curve. C. P. B.

947. *Orbits of* 44 *Eclipsing Binaries.* **H. Shapley.** (Science, 37. pp. 29–30, Jan. 3, 1913. Paper read before the Astronom. and Astrophys. Soc. of America.)—Using the methods developed by Russell, orbits have been computed for all eclipsing variable stars for which there exists reliable photometric data. In the majority of cases circular elements satisfactorily represent the observations. C. P. B.

948. *New Eclipsing Variable Stars.* **J. Stebbins.** (Science, 37. p. 26, Jan. 3, 1913. Paper read before the Astronom. and Astrophys. Soc. of America.)—It seems probable that a considerable number of the short-period spectroscopic binaries are eclipsing variable stars, and several of these have been investigated with the selenium photometer. α Virginis and α Coronæ Borealis are such variables, and β Scorpii is suspected. C. P. B.

949. *Spectroscopic Binary* 9 *Camelopardalis.* **O. J. Lee.** (Science, 37. p. 38, Jan. 3, 1913. Paper read before the Astronom. and Astrophys. Soc. of America. Astrophys. Journ. 37. pp. 1–24, Jan., 1913.)—Frost and Adams announced the dual nature of this system in 1904, basing the result on measures of broad lines. From observations covering 3000 days, the form of the velocity curve is incompatible with a simple two-body system, and a certain form of calcium envelope has been assumed. The period is 7·9957 days. C. P. B.

950. *Orbit of Binary System* ϵ *Hydræ A.B.* **R. G. Aitken.** (Science, 37. pp. 37–38, Jan. 3, 1913. Paper read before the Astronom. and Astrophys. Soc. of America.)—This close double star, discovered by Schiaparelli in 1888, may be analysed for orbital elements both visually and spectroscopically. The micrometer measures, give a period of 15·3 years. Other elements are given. C. P. B.

951. *Orbit of* λ *Tauri.* **F. Schlesinger.** (Science, 37. p. 34, Jan. 3, 1913. Paper read before the Astronom. and Astrophys. Soc. of America.)—Eighty-nine spectrograms of this bright Algol-variable have been secured with the Mellon spectrograph of the Allegheny Observatory. Elements of the orbit calculated from the photographic reductions are appended. The period is 3·9529 days. C. P. B.

952. *Spectrographic Observations of Algol.* **F. Schlesinger.** (Science, 37. p. 34, Jan. 3, 1913. Paper read before the Astronom. and Astrophys. Soc. of America.)—A series of spectrograms have been made with the Mellon spectrograph during the last six years, 336 plates being secured. The long-period oscillation in the radial velocities, first announced by Bélopolsky in 1906, has been confirmed, and this is accompanied by a similar oscillation in the times of light minimum. C. P. B.

953. *Chromospheric Lines in Spectrum of ϕ Persei.* **P. W. Merril.** (Lick Observatory Bull. No. 224. Nature, 91. pp. 94–95, March 27, 1913. Abstract.)—From a survey of B-stars having bright hydrogen lines the author concludes that the spectrum of ϕ Persei shows evidence of the presence of chromospheric radiations. The lines of helium, magnesium, and sodium show anomalies compared with the spectrum of the solar chromosphere. C. P. B.

954. *Spectrographic Observations of ϕ Persei.* **F. C. Jordan.** (Science, 37. p. 34, Jan. 3, 1913. Paper read before the Astronom. and Astrophys. Soc. of America.)—This has been known to be a bright-line star since 1889, and a period of variability given as 126·5 days. Preliminary measurements give a velocity curve different for the bright hydrogen lines and for the absorption lines, but not such a curve as would be due to a secondary body. C. P. B.

955. *Spectrum of Pleiades Nebula.* **Slipher.** (Lowell Observatory, Bull. No. 55. Nature, 91. p. 94, March 27, 1913. Abstract.)—From an exposure of 21 hours on the spectrum of the Pleiades nebula the author obtained a record showing continuous spectrum crossed by strong hydrogen lines and faint helium lines. No traces of the gaseous nebula lines could be detected. It is suggested that the nebula shines by reflected light from Merope. C. P. B.

956. *Magnitudes of Stars in Coma Berenices.* **Hnatek.** (Astronom. Nachr. No. 4629. Nature, 90. p. 710, Feb. 27, 1913. Abstract.)—From five plates taken with a 4-in. Anastigmat portrait lens, a series of photographic magnitudes of 104 stars in the cluster Coma Berenices have been determined. The comparisons with results of other observers show evidence that the differences vary with magnitude and spectral class. C. P. B.

957. *Spectra of Nova Geminorum* (1912). **S. B. Barrett.** (Amer. Philosoph. Soc., Proc. 51. p. 568, Oct.–Nov., 1912.)—Various notes are given showing the changes in the spectrum of Nova Geminorum (1912) as photographed at the Yerkes Observatory, including details of radial velocity, breadth of bands, etc. C. P. B.

958. *Proper Motions of Faint Stars.* **G. C. Comstock.** (Science, 37. pp. 32–33, Jan. 3, 1913. Paper read before the Astronom. and Astrophys. Soc. of America.)—Results are presented applying to 250 stars fainter than the tenth magnitude on the Harvard scale. C. P. B.

959. *Stellar Magnitudes, Parallaxes and Radial Velocities.* **G. Jäger.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 1629–1658, Oct., 1912.)—A discussion is given of the observations used in formulating the relations between the stellar groups of varying magnitude, parallax, and radial velocity, a series of tables showing the results for about 180 stars. C. P. B.

LIGHT.

960. *Autocollimating Mounting for Concave Grating.* **H. C. Richards.** (Amer. Philosoph. Soc., Proc. 51. pp. 554–563, Oct.–Nov., 1912.)—An autocollimating mounting is described whereby several of the disadvantages introduced in previous methods are more or less successfully eliminated. The chief of these consists in the provision of means whereby the necessity of separately adjusting the distance of the grating and inclination of the camera for each new angle of incidence is done away with. This is most ingeniously managed by the adoption of a "lazy tongs" connection between the grating and camera-slit, the total length when open being equal to the radius of curvature of the grating. The first and last link on one side are fixed normal to the grating and plate respectively. The camera is mounted on its platform on either side of the slit or preferably just above it, and may be adjusted so as to bring the plate into coincidence with the focal circle. If the slit be made double the apparatus may be used as a monochromatic illuminator of high purity. As everything is supported on one track the apparatus may be made quite rigid, and takes up much less space than the other forms of mounting for the concave grating. It is also very simple to fit the instrument with a light-proof cover, so that it may be used in an undarkened room. The most important disadvantage of the autocollimating method is that the spectra are not normal; the deviation, however, is small, and may readily be compensated. C. P. B.

961. *Plane Grating Spectrograph for Stellar Work.* **J. S. Plaskett.** (Science, 37. pp. 31–32, Jan. 3, 1913. Paper read before the Astronom. and Astrophys. Soc. of America.)—Preliminary tests have been made with a Littrow grating spectrograph of 37½ in. focal length, giving a dispersion of 17·5 Å. per mm. at H_γ. Comparisons are made of the efficiency of the instrument compared with that of a prismatic spectrograph of similar power, the grating instrument being distinctly superior towards the violet and ultra-violet. C. P. B.

962. *New Form of Spectrograph Collimator.* **P. Fox.** (Science, 37. pp. 26–27, Jan. 3, 1913. Paper read before the Astronom. and Astrophys. Soc. of America.)—In using a spectrograph in conjunction with large relative apertures such as those of large reflectors, a form of collimator is proposed consisting essentially of a small Cassegrain reflector. The light coming through the slit falls on the perforated concave mirror, which then throws the light upon a small perforated convex mirror, mounted immediately behind the slit. This second mirror is of such curvature that it throws a parallel beam through the perforation of the first mirror, on the prisms. The ratio of perforation to aperture in both cases is equal to the ratio of aperture of the telescope objective to the diagonal mirror, and the aperture of the convex mirror is equal to the perforation of the concave, so that there is no loss of light. C. P. B.

963. *24-inch Objective of the Sproul Telescope.* **J. A. Miller** and **R. W. Mariott.** (Science, 37. p. 29, Jan. 3, 1913. Paper read before the Astronom. and Astrophys. Soc. of America.)—This large objective was completed by

J. A. Brashear and Co. in Dec., 1911, for the Sproul Observatory of Swarthmore College. Extra-focal exposures on Capella were made through a screen containing 44 circular holes 33 mm. diam. and the results investigated according to Hartmann's method. Other tests were made on Arcturus with a different screen. The measures showed the presence of slight astigmatism, but the characteristic 0·274 shows the objective to be an excellent one.

C. P. B.

964. *The Optophone.* **E. E. Fournier d'Albe.** (Phys. Zeitschr. 13. pp. 942–943, Oct. 1, 1912.)—Two selenium bridges are balanced against two adjustable carbon resistances in a Wheatstone-bridge arrangement. A fine adjustment of manganin wire serves to make the balance so accurate that a high-resistance telephone makes no sound when the "galvanometer current" is sent through it and interrupted by a clockwork arrangement giving about 10 breaks per sec. Then, when one of the bridges is exposed to light, while the other is dark, a sound is heard in the telephone. The two Se bridges are mounted side by side in a camera-like box containing the clockwork and a 4-volt battery, and lights and luminous objects are perceived by means of the ear, the max. effect being produced by the strongest contrasts. E. E. F.

965. *Refractive Index of Selenium.* **W. S. Gripenberg.** (Phys. Zeitschr. 14. pp. 123–124, Feb. 1, 1913.)—When melted Se is pressed between plate glass, sheets from 20 to 250 $\mu\mu$ in thickness may be obtained [Abstract No. 920 (1912)]. In spite of rapid cooling, small circular portions, less than 0·2 mm. in diam. become crystalline. They show much greater absorption of light than the amorphous Se, and have a higher refractive index. The interference colours are of a higher order in the crystalline Se than in the amorphous Se. They show that the refractive index is from 1·16 to 1·27 times greater. This gives a refractive index 3·5 for sodium light, or the highest refractive index known among elementary substances. This result was confirmed by making a film of Se on glass by kathode disintegration and crystallising one-half of it. The crystallised half showed narrower interference rings than the amorphous half, the diameters being as 4 to 5.

E. E. F.

966. *Temperature Change of Refractive Index for Water.* **F. A. Osborn.** (Phys. Rev. 1. Ser. 2. pp. 198–210, March, 1913.)—The method here adopted is that first used by Reimerdes (Inaug. Dissertation, Jena, 1896). The change of refractive index is determined by the shift of interference fringes in a fused quartz system (which is represented in a figure), an Abbe-Pulfrich interferometer being employed (Zeitschr. für Instrumentenkunde, p. 261, 1898). The final results are shown in a graph and expressed by the equation $d\mu/dt = -10^{-7} \times (118{\cdot}73 + 41{\cdot}4184t - 0{\cdot}02376t^2 - 0{\cdot}0043757t^3)$, which represents the experimental determination to about one unit in the seventh decimal place. [See Abstract No. 52 (1913).] E. H. B.

967. *Torque by Beam of Light in Oblique Refraction through Glass measured Dynamically.* **G. Barlow.** (Roy. Soc., Proc. Ser. A. 88. pp. 100–102, Feb. 24, 1913.)—In a previous research the torque was measured statically [see Abstract No. 1677 (1912)]. It is here measured dynamically by its effect in changing the period of oscillation of the suspended glass cube. The mean value of the change in period derived from eight experiments is 0·162 sec. The theoretical value for the same case is calculated to be 0·158 sec., thus showing a satisfactory agreement. E. H. B.

968. *Selective Dispersion of Mercury Vapour.* **R. W. Wood.** (Phys. Zeitschr. 14. pp. 191–195, March 1, 1913. Phil. Mag. 25. pp. 433–439, April, 1913.)—Since mercury vapour can be kept in transparent vessels, and its density is accurately known, it is suitable for the study of selective dispersion in non-luminous absorbing gases. The end-plates of the vessel used by the author were of white fluorspar, since the double refraction of quartz would have introduced disturbances. The metallic deposit used was a kathode deposit of gold, as silver does not deposit well on fluorspar. The temperature was maintained constant by means of a hot-air bath worked by an aspirator. A low density of vapour was used, and an interferometer method of observing the dispersion. Only one absorption band was studied, that of wave-length 2536, which has the advantage of falling in the midst of a group of strong iron lines. On forming the vapour, the system of fringes passing along the length of the spectrum is displaced in the iron lines in different directions and by various amounts. The temperature ranged from 34° to 58° C., and the displacements did not exceed the width of one fringe. It is clear, however, that the refractive index of the vapour near the absorption band does not increase to an extent proportional to the density of the vapour. It is therefore very doubtful whether this absorption line is due to the normal mercury molecule. The dispersing molecule may either be an atomic complex or an ionised molecule, and probably such molecules are rare in comparison with normal molecules. In any case, the percentage of molecules in this condition decreases as the vapour density increases. Not all the molecules present take part either in absorption or dispersion. E. E. F.

969. *Liquid Mixtures especially suitable for observing Christiansen's Phenomenon.* **F. Bodroux.** (Comptes Rendus, 156. pp. 772–774, March 10, 1913.)—Under suitable experimental conditions, when two liquids with slight mutual solubility and with nearly equal refractive indices are shaken together vigorously so that an emulsion is formed, the mixture becomes clear at a certain temperature and brightly illuminated objects appear vividly coloured when viewed through it. This phenomenon was observed by Christiansen with suspensions of finely-divided solids in liquids of nearly the same refractivities. The use of white light generally gives a white colouration which, when the temperature is slightly raised, passes successively through orange, red, violet, and blue, the liquid ultimately becoming turbid. On cooling the liquid again, these colours reappear in the inverse order. Two solutions which show this phenomenon well are : (1) 15 c.cm. of ethyl acetate and 10 gm. of water poured into 50 gm. of saturated aqueous sodium chloride solution ; this mixture is extremely sensitive to heat, the warmth of the hand sufficing to change the colour shown. (2) To a solution of 25 gm. of sodium bromide in 35 gm. of water propyl alcohol is added drop by drop until the shaken mixture shows the desired colouration.

With certain mixtures, rise of temperature causes the appearance of the different colourations in the opposite order to that given above ; such are formed when ether and amyl alcohol are added to aqueous saccharose or glycerol solutions of suitable refractivity. T. H. P.

970. *The Photographic Plate.* IX. *The Latent Image.* V. **W. D. Bancroft.** (Journ. Phys. Chem. 17. pp. 93–153, Feb., 1913.)—The general conclusions drawn from a detailed consideration of the literature concerning the latent image are as follows :—The latent image must be a reduction product, since the action of light can be duplicated by that of a suitable reducing agent. It

cannot be free metallic silver or a single definite subhalide or a mixture of several such compounds, but must be regarded as a phase of continuously varying composition, probably of silver bromide with adsorbed metallic silver. The latent image is identical with the photohalides except as regards colour, and photoretrogression is due chiefly to the recombination of halogen with the latent image, apparently by adsorption. This adsorption theory furnishes an explanation of all the phenomena of solarisation. The latent image which yields a negative under normal development consists of silver bromide with an excess of about 0·002–0·1 per cent. of silver; with higher excesses of silver, positives are obtained on development. The second negative is not due to metallic silver. The latent images produced by heat, acids, pressure, etc., are unlike that produced by light, and do not necessarily involve a change in the ratio of silver to bromine, but are due to removal of gelatine, etc. [See Abstract No. 484 (1912).] T. H. P.

971. *Direct Photographic Positives.* **G. A. Perley** and **A. Leighton.** (Journ. Phys. Chem. 17. pp. 235–248, March, 1913.)—The production of a positive by the Waterhouse process is most easily influenced by alterations of the conditions governing the reaction. The variables considered in this preliminary paper are: time of exposure, temperature of development, time of development, size of plate, amounts of sodium carbonate, hydroquinone, thiocarbamide, sodium sulphite and water. The emulsion and actinic value of the light are kept constant. It is found that with a given concentration the temperature cannot be varied more than 1 deg. C. The quantity of developer, best expressed in plate surface units, governs the resultant positive. An excess of any constituent which favours an increase in the development of the latent image yields a partial negative (or a masked positive); an insufficient amount produces uniform development and a resultant fog. An excess of thiocarbamide acts as a solvent for the emulsion; an insufficiency does not visibly affect the thin negative resulting from normal development. A suitable restrainer for yellow fog and thin negatives would yield great improvements. The contrast and clearness of the final deposit depend much upon the emulsion on the plate. The sources of dissatisfaction with the present positive are: the bluish colour of the deposit, the necessity of a preliminary appearance of a thin negative, and the appearance by reflected light of a yellowish fog. Other experiments are in progress. A. E. G.

972. *Remarkable Case of Optical Resonance.* **L. Dunoyer.** (Comptes Rendus, 156. pp. 1067–1070, April 7, 1913.)—The phenomenon of diffuse surface resonance, noticed by Wood in the case of mercury vapour [see Abstract No. 1182 (1912)], may be readily observed with pure sodium vapour. A small flask, carefully freed from gas and containing a little sodium, is arranged in the hot gases of a chimney above a Bunsen burner. In front of the flask is placed the flame of a Méker burner fed with air charged with very dilute pulverised sodium chloride solution, the flame being surrounded by a chimney with a sharp-edged aperture. From any point outside the bundle of rays reflected regularly by the wall of the flask the image of the aperture is invisible so long as the flask remains cold. When the temperature of the flask exceeds 100° the trace of the exciting rays traversing the flask appears. The resonant luminosity increases gradually, and, just below 200°, it is no longer limited exactly by the path followed by the exciting rays, but becomes highly diffused and seems to fill the entire flask. As the tempera-

ture continues to rise this diffuse light diminishes more and more, as also does the penetration of the exciting light into the vapour. At about 250° the region of resonance has a depth of only 5–6 mm., and at 300° its thickness is no longer perceptible, so that, from whatever point the front face of the flask is viewed, so long as the visual ray does not traverse the vapour, the image of the source is seen as clearly as if it were formed on a sheet of white paper adherent to the inner wall of the flask. It is highly probable that, if the sodium vapour were rendered sufficiently dense, regular reflection would be observed, but attack of the glass by the vapour prevents this. In this connection it would be interesting to study the law of distribution of the light diffused in different directions, to ascertain if this law approaches that of regular reflection as the temperature rises. Observed through the flask filled with hot vapour the flame does not show appreciable diminution in brilliancy, and it would therefore seem probable that the useful exciting light is limited to a very narrow region in the centre of the D-rays. This is in apparent connection with the observation that the diffuse surface resonance image increases but slightly in brilliancy when the luminous source is augmented considerably in sodium and therefore in brilliancy. T. H. P.

973. *Absorption Coefficient in Electric Field.* **H. J. van der Bijl** and **G. Szivessy.** (Deutsch. Phys. Gesell., Verh. 15. 5. pp. 151–155, March 15, 1913.)—To explain the double refraction of an isotropic substance in an electric field theories have been put forward by Langevin, by Larmor, and by W. Voigt, that by the latter requiring a change in the absorption coefficient of the substance for light by the electric field. This point has been experimentally tested with the result that the change in absorption, if present, must be less than $\frac{1}{4}$ per cent. in CS_2 for an electric field of the order of 20,000 volts per cm. E. H. B.

974. *Emission and Absorption by Luminous Flames.* **R. Ladenburg.** (Phys. Zeitschr. 14. pp. 195–198, March 1, 1913.)—From investigations of the optical properties of strongly luminous hydrogen, the author concluded that the ratio of emission to absorption is different at different wave-lengths of the widened red hydrogen line H_α [Abstract No. 487 (1911)]. This apparent contradiction of Kirchhoff's law is attributed by Brotherus [Abstract No. 1363 (1912)] to a lack of homogeneity in the luminous gas. This explanation is refuted by some further experiments described by the author, in which the light from a hydrogen discharge is sent through a Wratten colour filter transmitting only the line H_α, and is then photographed and studied photometrically. Besides, layers of hydrogen a few mm. thick have not sufficient absorption to allow them to produce reversal phenomena. A possible explanation is that several types of emission-centres go to make up the line, and that the latter really consists of a line proper and a continuous luminous background. E. E. F.

975. *Interference with Wedge-shaped Plates.* **L. Janicki.** (Ann. d. Physik, 40. 3. pp. 493–498, March 20, 1913. Communication from the Physikal.-Techn. Reichsanstalt.)—A continuation of previous work [see Abstracts Nos. 55 and 65 (1913)]. Good agreement is found between measurements of the sharp interference bands obtained with two semi-silvered wedge-shaped plates of small angle, and the theory of von der Pahlen [Abstract No. 389 (1913)]. A. W.

976. *Analysis of Slightly Elliptical Light Vibrations.* **E. Perucca.** (Accad. Sci. Torino, Atti, 48. No. 3. pp. 161–181, 1912–1913.)—A full account of an experimental study of the half-shade polariser and compensator of Brace [Abstract No. 1013 (1904)], from which it is concluded that this is much more sensitive than any other method, having a probable error of less than 1′. W. H. St.

977. *Relation between Temperature and Rotation of Active Substances, for Light of all Refrangibilities.* **T. S. Patterson.** (Chem. Soc., Journ. 103. pp. 145–177, Feb., 1913.)—Evidence is given that the rotatory power of a very large number of substances after increasing with rise of temperature passes through a maximum value and then diminishes again. Maxima are also observed when rotatory power is plotted against wave-length in cases of "anomalous" rotatory dispersion. It is suggested that both results may be interpreted by supposing that rotatory power is a periodic function of temperature, wave-length, etc. A modified sine-formula is suggested as indicating the general nature of the function. T. M. L.

978. *Magnesium Spectrum.* **A. Nacken.** (Zeitschr. wiss. Phot. 12. pp. 54–64, March, 1913.)—Measurements of the arc and spark lines of Mg were made with a Rowland concave grating, 6·34 m. radius and 20,000 lines to the inch. The results, from λ6494 to λ4282 in terms of the international normal and from λ4282 onwards in terms of the normal of Buisson and Fabry, are tabulated and compared with the wave-length measurements of other experimenters. [See also Abstracts Nos. 245 and 1232 (1910).] A. W.

979. *Magnetic Rotation of Polarised Light by Liquid Nitrogen and Oxygen.* **J. Chaudier.** (Comptes Rendus, 156. pp. 1008–1010, March 31, 1913.)—Previous experiments on the magnetic rotation of polarised light by liquefied gases have only been undertaken in the case of readily liquefiable ones, *e.g.* sulphuretted hydrogen, nitrous oxide, methyl chloride. The author extends the study to gases difficultly liquefiable, such as nitrogen and oxygen which can now be obtained pure commercially. The classical apparatus of Verdet and Becquerel was employed, slightly modified in certain details to admit of the use of Dewar vacuum vessels and also to improve the mode of reading. After each determination corrections were necessary on account of the influence of the cylindrical glass vessel. When employing yellow sodium light the author finds that the magnetic rotation of the plane of polarisation is proportional to the intensity of the field and the thickness traversed when the active liquids are oxygen and nitrogen ; also, the sense of the rotation is positive, similar to water. The rotatory powers ρ^D for nitrogen and ρ^D_O for oxygen at 18° C. are :—

$$\rho^D_N = 0{\cdot}00415 = 0{\cdot}415 \times 10^{-2}.$$
$$\rho^D_O = 0{\cdot}00782 = 0{\cdot}782 \times 10^{-2}.$$

The magnetic rotatory power of oxygen is therefore approximately double that of nitrogen. For carbon disulphide at the same temperature,

$$\rho_{CS_2} = 0{\cdot}042 = 4{\cdot}2 \times 10^{-2}.$$

The author gives a table of the rotatory magnetic dispersions of liquid oxygen and nitrogen for light of different wave-lengths, drawing the following conclusions :—Nitrogen obeys the inverse square law of the wave-length, and

only disperses for vibrations of short wave-length ; its rotatory magnetic dispersion is near that of methyl chloride and less than carbon disulphide. Oxygen possesses a feeble rotatory magnetic dispersion, does not obey the inverse square law, and disperses in a contrary sense to carbon disulphide. The results are analogous to those obtained for gaseous oxygen and nitrogen. H. H. Ho.

980. *Absorption of Ultra-violet Light by Ozone and Limit of Solar Spectrum.* **C. Fabry** and **H. Buisson.** (Comptes Rendus, 156. pp. 782–785, March 10, 1913. Journ. de Physique, 3. Ser. 5. pp. 196–206, March, 1913.)—The limitation of the solar spectrum, a little below the wave-length 3000, has been attributed to absorption by ozone. This hypothesis is only based on the existence of a strong ozone absorption band in the ultra-violet. To confirm it, numerical values are necessary relating to atmospheric absorption and to absorption by ozone. These determinations have been undertaken by the authors. The results for ozone show that maximum absorption is found near λ2550. In this region the absorption is exceptionally great : a thickness of pure ozone of only 25 μ will reduce the intensity of the incident light by one-half. Between the wave-lengths 2900 and 3300 the absorption varies rapidly. Measurements of atmospheric absorption made in 1912 showed that for λ3000, the proportion of transmitted light is of the order of 1/100. To produce this absorption it would be necessary for the atmosphere to contain a quantity of ozone equivalent to a layer of pure ozone 5 mm. thick. If this were uniformly distributed, the proportion would be 0·6 cm.^{3} per m.^{3} of air, a quantity much greater than that given by chemical analysis. The most probable hypothesis is that ozone exists almost entirely in the upper layers of the atmosphere.
A. W.

981. *Wave-lengths of Krypton.* **H. Buisson** and **C. Fabry.** (Comptes Rendus, 156. pp. 945–947, March 25, 1913.)—The authors have previously shown [Abstract No. 1190 (1912)] that the rare gases of the atmosphere give extremely fine lines, especially when the discharge tubes are cooled in liquid air. For many purposes it seems to be advantageous to use these lines in preference to those of cadmium. A krypton tube requires no heating ; the two lines can be separated without dispersive apparatus, using absorbing media : chloride of didymium for the yellow line, eosine for the green. The two lines are in a region of the spectrum very favourable to visual observations, and are from this point of view superior to the Cd red line. A little distance from the green line is a very faint line (λ = 5563), which can be separated by dispersion, but which is so faint it gives no trouble if neglected. The authors have utilised their measurements of the order of interference obtained with the Cd and Kr lines to determine the wave-lengths of the green and yellow Kr lines ; the values found for the wave-lengths of Kr in air at normal pressure and at 15° C., using as standard the wave-length of the red Cd line given by Benoît, Fabry, and Perot, are 5570·2908 and 5870·9172, with possible errors of a few units in the last place. A. W.

982. *Spectrum of Helium in Canal Rays.* **J. Stark, A. Fischer,** and **H. Kirschbaum.** (Ann. d. Physik, 40. 3. pp. 499–541, March 20, 1913.)—A lengthy paper dealing with the spectrum of the singly and doubly charged helium atomions in canal rays. It was found that the max. velocity in the displaced line for He canal rays in He mixed with an electronegative gas is considerably greater than for He canal rays in pure He. In pure He the

displaced line bears to the stationary line a ratio very much smaller than in He mixed with an electronegative gas ; or, in other words, admixture of an electronegative gas increases, in the spectrum of He canal rays, the ratio of the displaced line to the stationary line. The He line λ4472 is found to have for carriers the positive singly-charged He atomions, while the carriers for the line λ4388 are doubly-charged atomions. More generally, the authors conclude that the principal series and the two subordinate series of doublets have for carriers the positive singly-charged He atomion ; the principal series and the two subordinate series of simple lines of He have for carriers the positive doubly-charged He atomions. Runge and Paschen associate the first set of these series with "helium," the second set with "parhelium." [See Abstracts Nos. 1069 (1907), 653 (1911), 601 (1913).] A. W.

983. *Mutual Influence of Spectrum Lines of Same System in the Magnetic Field.* **G. Wendt.** (Ann. d. Physik, 40. 3. pp. 607–608, March 20, 1913.)—In view of the publications of F. Paschen and E. Back, and also of W. Voigt, the author draws attention to his results and remarks on the same subject [see Abstract No. 867 (1912)]. Also he has found that in the case of some very bright lines the shading-off is discontinuous, *i.e.* may be resolved into fine lines. As the separation of these lines decreases with decreasing wavelength he concludes that it is a case of interference fringes. J. M.

984. *Spectrum of Carbon Arc at Low Pressures.* **M. La Rosa.** (Ann. d. Physik, 40. 3. pp. 542–550, March 20, 1913.)—Describes the phenomena of the carbon arc spectrum at low pressures in greater detail than in the author's previous paper [Abstract No. 1362 (1912). See also Abstract No. 2055 (1909).] A. W.

985. *Series Systems in the Spectra of Zinc, Cadmium, and Mercury.* **F. Paschen.** (Ann. d. Physik, 40. 3. pp. 602–605, March 20, 1913.)—A continuation of previous work [see Abstracts Nos. 1486 (1911) and 419 (1913)]. Fresh evidence is brought forward in support of the author's combination series formulæ. [See also Abstract No. 598 (1913).] A. W.

986. *Electron Theory of Phosphorescence.* **C. A. Butman.** (Phys. Rev. 1. Ser. 2. pp. 154–160, Feb., 1913.)—According to the author's theory of phosphorescence, the incident light causes the electrons in the light-emitting atom of the complex phosphorescent molecule to be brought to a critical energy-content causing the selective emissions characteristic of the substance. At the same time the light causes electrons to be ejected from the photoelectric atom, return of these electrons to the molecule by collision causing the luminosity to continue. In the case of the alkaline earth sulphides, this theory regards the photoelectric atom as sulphur, whereas Lenard's theory indicates it to be the heavy metal. Evidence in support of the author's view is discussed. [See also Abstract No. 1873 (1912).] T. H. P.

987. *Luminescence of Phosphorus Vapour.* **H. Schmidt.** (Phys. Zeitschr. 14. pp. 120–123, Feb. 1, 1913.)—Saturated solutions of phosphorus in almond oil and phosphorus emulsions in water were used. Various gases were pumped through the liquids, and the bubbles ascending through them showed a luminescence, which, however, ceased as soon as all the traces of oxygen had been displaced. As soon as this occurred, the gases issuing from the orifice of the bottle showed luminescence on getting into contact with the atmo-

sphere. All this was observed in the case of CO_2, H, and N_2O. Coal-gas did not show the same phenomena; it stopped the luminescence and the formation of fog. Oxygen, on the other hand, may be saturated with phosphorus vapour and show little luminescence until on arriving in the air its partial pressure decreases and an intense glow is produced. The ionisation of air by phosphorus fumes were studied, but the results were inconclusive as regards the process of ionisation. E. E. F.

988. *Theory of Luminescence.* **E. Pringsheim.** (Phys. Zeitschr. 14. pp. 129–131, Feb. 15, 1913.)—Considering the similarity between the dispersion electrons and Planck's resonators it is probable that many considerations applicable to the latter also apply to radiant energy from gases, whether that be temperature radiation or luminescence. In vacuum tubes, and in spark and arc discharges, we probably have to do with luminescence due to electrical processes. It is remarkable that here also the relative intensity of the shorter waves increases with the degree of excitation. This is intelligible on the theory of quanta, since with a greater incident energy the cases become more frequent in which a resonator of high frequency receives energy sufficient to lead to the emission of a quantum. Assuming that the emissive and absorptive powers are independent of the density of radiation, the author traces an analogy between luminescent bodies and black bodies on the basis of the quanta theory. He shows that the ratio of emission to absorption for all wave-lengths at which there is emission (owing to the presence of dispersion electrons) changes with the wave-length from one spectrum line to another in the same way as the emissive power of the black body does at the "specific temperature." The latter (Bauer's "emission temperature") is for a given wave-length that temperature at which the emissive power of the black body equals the ratio of emission to absorption in the radiating body. Then the difference between this specific temperature and the true temperature of the radiator gives a measure of the deviation from Kirchhoff's law and for the degree of luminescence. E. E. F.

989. *Diffraction of Short Electromagnetic Waves by a Crystal.* **W. L. Bragg.** (Cambridge Phil. Soc., Proc. 17. 1. pp. 43–57, Feb. 14, 1913.—A mathematical discussion of the experimental results of Friedrich, Knipping, and Laue on interference phenomena with Röntgen rays [K. Bayer Akad. München, Ber., June, 1912; also Abstract No. 266 (1913)]. E. H. B.

990. *Reflection of X-rays.* **H. Moseley** and **C. G. Darwin.** (Nature, 90. p. 594, Jan. 30, 1913.)—Studying the grazing reflection of X-rays from mica, the authors find that the reflected beam resembles ordinary X-rays. It ionises air and helium and produces a soft radiation when it strikes metals. The variation of its ionisation in air with pressure is also similar. Effects are obtained as great as 1 or 2 per cent. of the primary beam. The same absorption of the reflected beam is produced by aluminium, whether the rays pass through it before or after reflection. This indicates that the character of the rays is unaltered by reflection. The amount of reflection increases, however, with the hardness. The energy of the X-rays appears to show the contrary properties of extension over a wave-front and concentration in a point. E. E. F.

991. *Reflection of X-rays.* **W. H. Bragg.** (Nature, 90. p. 219, Oct. 24, 1912.)—Referring to the observations of Friedrich, Knipping, and Laue

[Abstract No. 266 (1913)] the author finds that when the crystal (zincblende) is placed so that the incident rays are parallel to an edge of the cube in the crystal the positions of the spots are to be found by the following simple rule. The atoms being assumed to be arranged in rectangular fashion, any direction which joins an atom to a neighbour at a distance *na* from it, where *a* is the distance from the atom to the nearest neighbours and *n* is a whole number, is a direction which a deflected (or secondary) pencil will take, and it will in doing so form one of the spots. In other words, we have to seek for all the cases in which the sum of three squares is also a square, and we then recover the positions of all the spots on the diagram. For example, secondary pencils take the directions (2, 3, 6) (4, 1, 8), and so on. In a few cases the sum of the squares is one short of a perfect square, *e.g.* (5, 7, 11), but in no case is it on the greater side ; and there is at least one direction (2, 5, 14) which ought by the rule to be on the diagram and is not. Otherwise the rule is quite successful. L. H. W.

992. *Photographic Effect of X-rays and X-ray Spectra.* **C. G. Barkla** and **G. H. Martyn.** (Phil. Mag. 25. pp. 296–300, Feb., 1913.)—It is well known that the absorption properties of any material for X-rays depend largely on the nature of the characteristic X-rays of the elements contained in the material. In the present paper this question has been studied for the silver and bromine atoms contained in the grains in the emulsion of a photographic plate. A photographic plate was exposed to the characteristic X-radiations of series K from various elements. The exposure was made for a period sufficient for the various radiations to produce the same total ionisation in air in an electroscope. After development of the plates it was found that the radiations had not produced equal photographic effects, that for Ce, for example, being about 2·7 times that for Cu. The variations of the photographic effects with the atomic weight of the radiator were, however, somewhat anomalous, being approximately constant for elements of lower atomic weight than Br, then increasing rapidly and becoming again approximately constant for elements with atomic weights between those of Br and Ag. With further increase of atomic weight of radiator another rapid increase in photographic effect was observed until the effect became again constant up to the material of highest atomic weight investigated, *i.e.* Ce. The results are exhibited by plotting the photographic effect determined as above against the "wave-length" of the characteristic radiation employed, the "wave-length" being calculated by equating Planck's quantum ($h\nu$) to the energy of the maximum-velocity electrons set free from a plate by the particular characteristic radiation (*i.e.* $v = \text{at. wt.} \times 10^5$). The general results show that when the absorption in AgBr relative to that in air increases either through the Br or through the Ag, the increase in photographic effect is approximately proportional to the increase in absorption. E. M.

993. *Reflection of X-rays.* **C. G. Barkla** and **G. H. Martyn.** (Nature, 90. p. 647, Feb. 13, 1913. Phys. Soc., Proc. 25. pp. 206–214 ; Discussion, pp. 214–215, April 15, 1913.)—By allowing a divergent pencil of Röntgen radiation to fall at nearly grazing incidence on one of the sets of cleavage planes of a crystal of rock-salt, and observing the intensity of the reflected pencil by a photographic plate, the authors find a series of well-marked and equal-spaced maxima in positions corresponding to equal increments of $\cos\theta$, where θ is the angle of incidence of the radiation on the cleavage planes. In the directly transmitted beam there is no indication of variation of

intensity with angle of incidence. There appears to be a series of X-ray spectra of different orders due to agreement in phase of waves from successive layers of molecules. Calculating on this assumption the authors get a wave-length of the order of magnitude in agreement with that calculated from the velocity of ejection of electrons by a substance exposed to this particular radiation. E. E. F.

994. *Interference Bands from Röntgen Rays.* **E. Hupka** and **W. Steinhaus.** (Deutsch. Phys. Gesell., Verh. 15. 5. pp. 162–163, March 15, 1913. Communication from the Physikal.-Techn. Reichsanstalt.) — The authors find that if Röntgen rays fall at almost grazing incidence on mica or rock-salt the reflected image when photographed is divided into two parts by a clear median space. Further, of the two reflected images photographed, that which is farther from the transmitted image shows parallel bands perpendicular to the plane of reflection. The paper has one figure showing the X-ray tube, the chamber containing the oblique crystal and the photographic plate. Another figure is a reproduction of the photograph on which six dark bands are clearly visible. (Ibid. pp. 164–166, March 15, 1913.)—The authors now assume that the reflections of the X-rays occur at the various molecular layers, and thus give rise to a number of virtual images of the actual source on the antikathode. Hence, reckoning the interference in the usual way from these sources, the experimental data lead to the value of the wave-length for these Röntgen rays $\lambda = 1{\cdot}8 \times 10^{-10}$ cm. Walter and Pohl from direct diffraction experiments found an upper limit of $\lambda = 1{\cdot}2 \times 10^{-9}$ cm. W. Wien at first found from energy measurements—

$$\lambda = (1{\cdot}15 \text{ to } 2{\cdot}3) \times 10^{-10} \text{ cm.}$$

More recently Wien has found from Planck's *Wirkungsquantum* the value $\lambda = 6{\cdot}5 \times 10^{-9}$ cm. E. H. B.

995. *Reflection of X-rays.* **H. B. Keene.** (Nature, 91. p. 111, April 3, 1913.)—In continuation of the experiments of W. L. Bragg [Abstract No. 604 (1913)] the author has investigated the reflection of X-rays by mica. A narrow pencil of X-rays was allowed to fall on a sheet of mica at an angle of incidence of 70°, a photographic plate being placed perpendicular to the plane of the mica. On the incident side of the mica five beams were shown on the developed photographic plate, that obeying the ordinary laws of reflection being the most obvious. On the "transmitted" side of the mica there were not less than thirty distinct beams, those of greatest photographic intensity being those which had suffered least deviation. Besides giving rise to numerous pencils in definite directions, the mica sheet exhibits the ordinary incidence and emergent scattering, which cause a general fog of the plate. Similar effects were obtained using rock-salt and galena. E. M.

996. *Röntgen Radiation from Kathode Particles traversing a Gas.* **R. Whiddington.** (Cambridge Phil. Soc., Proc. 17. 1. pp. 144–146, Feb. 14, 1913.)—The experiments described show that when very slow kathode particles traverse a gas at low pressure, Röntgen rays are emitted all along their path. Kathode rays from a lime kathode were projected along a tube provided with a side-tube. In the side-tube an Al electrode was arranged inside an earthed evacuated cylinder provided with a very thin window facing the kathode stream. The Al electrode was found to acquire a positive charge due to the emission of negative particles under the influence of the

Röntgen rays falling on it, further support of this view being obtained by applying a metal stop or a transverse magnetic field in front of the window. The velocity of the kathode particles emitted from the electrode due to the incident Röntgen radiation was found to be not far different from the velocity of those streaming out of the lime kathode. E. M.

997. *Production of Fluorescent Röntgen Radiation.* **J. C. Chapman.** (Phil. Mag. 25. pp. 359–370, March, 1913.)—Bragg and Porter [Abstract No. 1496 (1911)] have suggested that not only is ionisation by X-rays an indirect phenomenon due to β-rays, but that, in addition, the fluorescent or characteristic X-rays themselves are possibly due also to action of the β-rays. To settle this point, as to whether the characteristic X-rays are produced directly or indirectly, experiments were made so that in the case of one radiator the β-corpuscles were certainly absorbed in the radiating substance, while in the case of another radiator the corpuscles lost their energy in a substance in which it is impossible to produce measurable secondary characteristic radiation. The two radiators were constructed of thin sheets of gold and paper, so as to have the same mass of each substance, but arranged differently in the two cases. The intensity of the characteristic gold radiation excited in each radiator was the same, although on Bragg's hypothesis a ratio of 1·9 should have been shown. The experiments are evidence, therefore, that the atom from which the electron is ejected is the seat of the production of the characteristic radiation. E. M.

998. *Secondary Radiation produced by α-Particles.* **B. Bianu.** (Comptes Rendus, 156. pp. 785–788, March 10, 1913.)—In the present paper evidence is given showing that when α-particles of polonium fall on a metal plate a negatively-charged ionising radiation is emitted. The polonium is placed in a shallow dish facing the metal plate, and the ionisation current measured at different pressures beyond a wire gauze placed underneath the dish. A magnetic field almost suppresses the ionisation, the small residue being probably due to α-particles diffusely reflected from the plate. The value of the velocity is deduced to be $1{\cdot}8 \times 10^{-9}$ cm. per sec., and the product of the range (mm. of air) and pressure (mm. of Hg) about 100. The amount of radiation is practically independent of the nature of the metal on which the α-particles fall. E. M.

999. *Occlusion of Products of Radium.* **Costanzo.** (Comptes Rendus, 156. pp. 126–127, Jan. 13, 1913. Extract.)—Curie's experiments led to the conclusion that with metals there is no appreciable occlusion of RaEm, but he had only used Al, Cu, Pb, Bi, Pt, and Ag. The author has used Pd, and has found that this metal has similar properties for the disintegration products of Ra to those it possesses for hydrogen. Circular discs of Pd were employed 2 cm. in diam., and respectively 1 mm., 0·5 mm., 0·1 mm. thick. After drying and washing with ether, they were introduced into an enclosure containing the radio-active material together with three corresponding discs of india-rubber and three of brass for comparison. Examination of the discs after being in the enclosure for 48 hours gave the following results:—(1) Brass follows the laws established by Curie for induced radio-activity. (2) Palladium shows the phenomenon of occlusion of the disintegration products of Ra almost to the same degree as indiarubber for sufficiently thin plates. (3) The thickness of the active plates appears to have, in the phenomenon of occlusion, a small influence which is not as yet sufficiently defined, but which

is, however, appreciable. (4) For thick plates, and under the conditions of experiment, the activity observed on withdrawing the plate from the enclosure, is at first much greater with Pd than with indiarubber. The author suggests replacing the metallic wires used for studying induced radio-activity, especially in the atmosphere, by Pd wires. The phenomena of occlusion may also be employed for estimating the radium-content of the material in the enclosure, for the quantity of the Ra products absorbed by a plate of given surface and thickness is, for a sufficiently long exposure and under identical conditions of experiment, proportional to the quantity of Ra in the enclosure. A. W.

1000. *Relations between Radio-active Elements emitting α-Rays.* **R. Swinne.** (Phys. Zeitschr. 14. pp. 142–145, Feb. 15, 1913.)—There is a quantitative relation between the atomic constants, the decay constant, and the initial velocity of the α-particles expelled by radio-active elements which can be expressed by different formulæ giving nearly the same results [see Abstracts Nos. 163, 696 (1912)]. The author finds that the difference between the initial velocity of an α-radiator of one family and that of the corresponding member of another family is nearly constant for these two families. Thus the radio-active disintegration forming chemically analogous elements in the various radio-active series takes place by steps which are not the same in different series, but differ by nearly constant quantities. A new relation discovered by the author is that the decay constants of the analogous α-radiators of different families stand in a nearly constant ratio to each other. E. E. F.

1001. *Variation in Activity of Uranium Nitrate.* **M. La Rosa.** (Giornale di Sci. naturali ed economiche, 29. Palermo, 1912. N. Cimento, 5. Ser. 6. pp. 73–82, Jan., 1913.)—The activity of uranium nitrate is found to be diminished by the radiations from an electric arc, by warming to 100°, and by drying the surrounding air, these effects being attributed by the hygroscopic nature of the salt and to the solubility of its emanation. W. H. Si.

HEAT.

1002. *Thermal Radiation from Hot Gases.* **W. T. David.** (Phil. Mag. 25. pp. 256–270, Feb., 1913.)—Gives first a brief review and criticism of the experimental work which has been done on the emission of thermal radiation from hot gases. Probable theories of the origin of radiation from gases are also dealt with. The question as to whether a hot gas can emit radiation in virtue of its temperature alone is discussed, and though further experimental work is necessary before the question can be definitely settled, it seems highly probable that the low-frequency vibrations of CO_2 and water-vapour giving rise to infra-red radiation are excited by molecular collisions. Paschen's experiments on the emission from hot CO_2 and water-vapour have been looked upon as affording conclusive evidence that molecular collisions excite the low-frequency intra-molecular vibrations of these gases, but the author shows that in these experiments the absorption of radiation from the hot tube walls might possibly be responsible for exciting these radiations. Experiments are suggested to settle this question. In experiments by Hopkinson and the author [Abstract No. 1703 (1911)], a greater max. pressure and a slower rate of cooling of a gaseous mixture after explosion was found when the walls of the explosion vessel were reflecting than when they were black. Also the radiation emitted from a certain thickness of the gaseous mixture is greater when the walls of the vessel are reflecting than when black. The most natural interpretation of these experiments is that the radiation reflected back into the gaseous mixture from the polished walls goes primarily to increase the energy in the vibratory degrees of freedom of the molecules, and that this excess is then partitioned off into the translational and rotational degrees during molecular collisions. A. W.

1003. *Resonance with the Longest Thermal Waves.* **R. W. Wood.** (Phys. Zeitschr. 14. pp. 189–191, March 1, 1913. Phil. Mag. 25. pp. 440–443, April, 1913.)—Describes experiments with waves of the order of 0·1 mm., obtained from an incandescent gas-burner by the method of focus isolation. Various metallic resonators suitable for the study of these long waves are described. One type consists of powdered copper dusted on to quartz plates. The deposits are nearly opaque to visible light, but transmit long heat-waves perfectly. The same amount of metal, deposited as a coherent sheet, would be quite opaque to long waves. Finely-divided deposits are obtained in the shape of a "dew" deposited on quartz plates by mercury vapour, the diam. of the droplets ranging from 0·01 to 0·08 mm., according to the length of exposure to the vapour. The degree of opacity of each plate is compared with that of a quartz plate by measuring the amount of energy transmitted when the wave-length is 1 μ, the measuring instrument being a radio-micrometer. For this wave-length each droplet acts simply on an opaque obstacle. For the longest thermal waves, the transparency is perfect so long as the diam. of the droplets does not exceed 0·1 of the wave-length. When the diam. is about $\frac{1}{4}$ of the wave-length, the transparency for the longest heat-waves is not much greater than for the short ones. With still greater diameters, the transparency for both kinds of waves is about the same. In no case is the transparency of the resonating plate less for the long waves than for the

short. This means that each drop only intercepts whatever energy actually falls upon it, and withdraws nothing from the neighbouring regions. On the other hand, when a sheet of silver deposited on quartz is split up into small rectangles by means of a dividing engine cutting the portions as small as 0·1 of a wave-length, the sheet is as opaque as before, nor is its conductivity changed. E. E. F.

1004. *The Constants of Spectral Radiation of a Uniformly Heated Enclosure.* **W. W. Coblentz.** (Washington Acad. Sci., Journ. 3. pp. 177–180, April 4, 1913.)—The temperature scale used in the investigation for temperatures above 1400° C. is the optical scale, which is obtained by adding to the thermoelectric temperatures certain values which are the mean of several groups of thermo-couples. For temperatures above 1400° C. an abrupt rise in the value of the constant c in Wien's formula was noticed [Abstracts Nos. 80, 437, and 1167 (1907)] ; but this was found to be due to taking too large correction factors for reduction to the optical scale. The mean value of the constant c from the two years' work is $c = 14{,}456 \pm 4$, while $A = 2911 \pm 1$. Computing similarly the values obtained by Lummer and Pringsheim and by Paschen the mean values of c would be $14{,}465 \pm 40$ and $14{,}458 \pm 25$ respectively. Warburg gives recently a mean value $c = 14{,}374 \pm 4$. The mean value from the four sets of observations may be taken as $c = 14{,}420$ mikron deg. and $a = 2905$ mikron deg.

The following is the summary of the results of the series of observations :—

Series.	Number of Energy Curves.	Mean Value c.	Remarks.
1911			
I	26	14,469	Unpainted Marquardt porcelain radiator
1912			
I	7	14,463	Radiator as in 1911. New optical adjustments
II	14	14,432	Radiator painted with chromium oxide
III	7	14,466	New unpainted Marquardt radiator
IV	9	14,446	Radiator painted with the oxides of cobalt and chromium
V	14	14,476	Radiator repainted ; new optical adjustments
VI	8	14,461	New thermo-couples ; radiator as in preceding series
VII	9	14,436	New water-cooled shutter ; rest of apparatus as in preceding series

J. J. S.

1005. *Spectro-photometric Comparison of the Emissivity of Solid and Liquid Copper at High Temperature with that of a Full Radiator.* **C. M. Stubbs.** (Roy. Soc., Proc. Ser. A. 88. pp. 195–205, March 31, 1913.)—In a previous paper [Abstract No. 442 (1913)] the author and Prideaux gave the results of a spectro-photometric comparison of the emissivity of solid and liquid gold at high temperatures with that of a full radiator or "black body." For solid

gold, the curve for relative emissivity against wave-length was shown to be similar to, but not identical with, that for absorptivity at low temperatures obtained by other workers. Whether the difference was due to a difference in the structure of the surfaces examined or to a real temperature-coefficient of the absorptivity remained an open question. The author now describes a similar investigation of the emissivity of copper and silver. The method used and apparatus employed were only modified in few details from those of the former paper. The "black body" used was of the Lummer-Kurlbaum type [Abstract No. 1871 (1901)] and its peculiarities receive detailed description. Temperature was measured by a thermo-couple, while the apparatus was so arranged that the radiating chamber could by actual trial be made to coincide with the region of uniform temperature. The heating was by means of two windings of "nichrome" No. 22 resistance wire, on independent circuits, insulated from each other and from the iron tube by several layers of asbestos paper; the outer one was, as suggested by Waidner and Burgess, wound more closely at the ends than in the middle. The advantages obtained are evenness of temperature distribution, and automatic lining of the walls of the chamber, on heating, with iron-oxide, which possesses a good degree of "blackness." Both the copper and silver were kept in a reducing atmosphere to avoid surface oxidation of the former and dissolution of oxygen in the latter, which, if incurred, would result in a considerable lowering of the freezing-point with consequent uncertainty in temperature measurement and possibly also a change in emissivity. Experiments with necessary precautions and attendant difficulties are then described in detail. As in the case of gold, the emissivity of copper is found to be discontinuous at the melting-point although the difference between that of the solid and liquid is less marked. Previous measurements on the radiation from liquid copper have been made by Burgess, and the wide disparity between his values and the author's is discussed. As an explanation Burgess's results are said to be in error owing to lack of monochromatism of the coloured glasses used in his pyrometer, and to far less favourable experimental conditions. Previous results of Hagen and Rubens, Miner, and Tool then receive critical consideration. The conclusion is unavoidable that the absorptivity in the visible spectrum of a polished copper surface changes on heating, a change only suggested in the previous paper for gold. The "relative emissivity" of liquid silver was found to be remarkably low throughout, but seemed to be somewhat greater than the corresponding values of the absorptivity of solid silver at ordinary temperatures. "Black-body" temperatures of solid and liquid copper and of liquid silver at the respective melting-points are calculated. H. H. Ho.

1006. *Mode of Combustion of Carbon.* **T. F. E. Rhead** and **R. V. Wheeler**. (Chem. Soc., Journ. 103. pp. 461–489, March, 1913.)—In continuation of their previous work, showing that carbon dioxide and monoxide are produced together when carbon is burned [see Abstract No. 1227 (1912)], the authors have made experiments to account for this simultaneous production of the two oxides. It is found that, at all temperatures up to 900° and probably above, carbon pertinaciously retains oxygen, which can be removed, not by exhaustion alone, but only by exhaustion and increased temperature together. When rapidly released in this manner the oxygen appears as a mixture of the two oxides of carbon, the proportion between the two depending on the temperature at which the carbon has been heated during oxygen fixation. It is shown that no physical explanation alone can account for this fixation of oxygen, which is probably the outcome of a

physico-chemical attraction between oxygen and carbon, since it seems hardly possible to assign any definite formula to the complex formed which varies in composition, whilst no isolation of the complex can be effected by physical means. Decomposition of the complex by heat produces CO_2 and CO, in definite proportions at a given temperature. Nearly these same proportions are found when a rapid current of air at a given temperature is passed over carbon previously saturated with oxygen at the same temperature. T. H. P.

1007. *Latent Heat of Vaporisation of Metals.* **E. van Aubel.** (Comptes Rendus, 156. pp. 456–457, Feb. 10, 1913.)—The author verifies Trouton's law that the molecular heat of vaporisation of a liquid, divided by the temperature (Kelvin) of ebullition at atmospheric pressure is a constant which is approximately 20. The following figures are obtained from Landolt-Börnstein's tables :—

Metal.	Temperature (Kelvin) of Ebullition.	Atomic Weight.	Latent Heat of Vaporisation.	Trouton's Constant.
Mercury	630°	200·0	63·6	20·20
Cadmium	1051°	112·4	181·0	19·36
Zinc	1191°	65·4	365·8	20·08
Bismuth	1708°	208·0	161·5	19·66
Magnesium.....	—	24·3	1700·0	—

Assuming that Trouton's constant is 20 for magnesium, we deduce that its melting-point is 1792°. Ditte gives 1100°, Greenwood 1120°, and v. Wartenberg 2200°, but Grüneisen from theoretical considerations computed the boiling-point to be 1810° Kelvin, which is in good agreement with the result found by Trouton's law. A. R.

1008. *Latent Heats of Vaporisation and Maximum Pressures.* **A. Leduc.** (Comptes Rendus, 156. pp. 225–227, Jan. 20, 1913.)—The determination of the heats of vaporisation of liquids at their boiling-points is comparatively easy, but the results obtained by different investigators at other temperatures show considerable divergence. Variable numbers have also been obtained for the vapour pressures of liquids at different temperatures.

Making use of the value of the specific volume of the saturated vapour, μ', derived from his own equation of state, $MF\mu' = RT\phi$, the author has calculated the heats of vaporisation of water at 100°, 130°, and 160° ; of ether at 10°, 30°, and 50° ; and of benzene at 60°, 80°, and 100°, by means of Clapeyron's formula, $L = T/J \,.\, (\mu' - \mu) \,.\, dF/dT$, where F represents the vapour pressure. The calculated results differ from the observed values, especially with ether and benzene, and the author suggests the desirability of fresh measurements on the pure substances and of converting the temperatures used to the thermodynamic scale. T. H. P.

1009. *Vapour Pressures of the Alkali Metals.* **A. Kröner.** (Ann. d. Physik, 40. 3. pp. 438–452, March 20, 1913.)—The method used in determining the vapour pressures of the alkali metals consisted in measuring the pressure of an indifferent gas, nitrogen, in the apparatus at a constant temperature, introducing the metal, and measuring the increase in pressure

caused thereby; the determinations were carried out at constant pressure and not at constant volume. The vapour pressures of cæsium and potassium were determined for temperatures varying between 249·5° and 355·5° C. for the former metal, and 249·5° and 398·6° for the latter metal. The rule of Ramsay and Young was then applied in order to calculate the boiling-points of these and the other alkali metals. T. S. P.

1010. *Determination of the Heats of Solution of Metals by means of a Vacuum Flask Calorimeter.* **E. E. Somermeier.** (Phys. Rev. 1. Ser. 2. pp. 141–153, Feb., 1913.)—The adiabatic calorimeter used by Richards and Burgess [Amer. Chem. Soc. 22. p. 431, 1900] for the purpose of eliminating radiation entirely is costly and slow, so that, for reactions occupying as long as 15 or 30 minutes, the author suggests the use of a Dewar flask, with which the correction for radiation and conduction is reduced to a very small amount. The errors accompanying the use of such a flask are discussed, and the amounts of heat developed in various reactions have been measured in order to ascertain the accuracy of the method. Three determinations of the heat of fusion of ice gave the values, 79·98, 79·88, and 79·89, the mean 79·92 being in almost exact agreement with Smith's value [see Abstract No. 2936 (1904)]. Measurements of the amounts of heat liberated when various metals were dissolved in acids also gave satisfactory results. T. H. P.

1011. *Energy Absorbed in Photochemical Reaction.* **V. Henri** and **R. Wurmser.** (Comptes Rendus, 156. pp. 1012–1015, March 31, 1913.)—Experiments were made in two ways, and from them and data as to the eye three estimates are obtained as to the energy required per molecule in a photochemical reaction. The values are: $6{\cdot}4 \times 10^{-14}$, $5{\cdot}5 \times 10^{-15}$, and $3{\cdot}96 \times 10^{-12}$. The last named is for the eye if only one molecule is decomposed in one-hundredth of a square millimetre, which is inadmissible. Hence, in each case, the energy in question is less than the energy quantum of Einstein. E. H. B.

1012. *New Thermodynamic Consequence of the Quanta Hypothesis.* **M. Pólányi.** (Deutsch. Phys. Gesell., Verh. 15. 5. pp. 156–161, March 15, 1913.)—Points out a complete analogy between the states of zero absolute temperature and infinite pressure; in such case the specific heat, the radiation, the entropy content, and entropy differences are zero. E. H. B.

1013. *Quanta Theory of Gases and Liquids.* **H. Tetrode.** (Phys. Zeitschr. 14. pp. 212–215, March 1, 1913.)—If Nernst's supposition is correct that gases, like solids, have zero specific heat at the absolute zero of temperature, it becomes possible to treat gases by the methods applicable to condensed systems, and no "chemical constant" need be specially introduced. Since a gas at the absolute zero cannot occupy a finite space in a stable condition, it must be regarded as a supersaturated vapour. This artifice is as legitimate as Maxwell's derivation of the vapour pressure of a liquid from the equation of condition. The error introduced in the entropy of a gm.-mol. by the deviation of such a vapour from the ideal gas laws can be minimised by making the ordinary volume of the gas so large that it only reaches or exceeds the saturation pressure at a very low temperature. The author applies the method of Debye [Abstract No. 446 (1913)], but deals with cubical instead of spherical volume elements, thus greatly simplifying the reasoning, and approximating

it to that familiar from the theory of radiation. The terms in Debye's formulæ which refer to transverse waves are omitted in the case of liquids and gases. The formulæ obtained show that at the higher pressures the quanta effects should become appreciable even at the ordinary temperatures, and should be superimposed upon the van der Waals' corrections. But the author admits that the results are only provisional. E. E. F.

1014. *Theory of Solids.* **S. Ratnowsky.** (Deutsch. Phys. Gesell., Verh. 15. 3. pp. 75–91, Feb. 15, 1913.)—Discusses the difference between Grüneisen's equation of condition for solid bodies [Abstract No. 268 (1913)] and his own [Abstract No. 1544 (1912)] in which the Planck-Einstein function appears, thus making it possible to deduce the effect of temperature. The discrepancies between the theoretical and experimental coefficients of expansion (diamond, etc.), induced the author to frame a new equation of condition, based, like Debye's formula for specific heat, upon a plurality of frequencies instead of one characteristic frequency. E. E. F.

1015. *Dissipation of Energy.* **L. Décombe.** (Journ. de Physique, 3. Ser. 5. pp. 89–101, Feb., 1913.)—The author discusses the question of the dissipation of energy from the much-debated standpoint as to whether it is capable of mechanical interpretation, *i.e.*, whether it may be explained on the same principles as those forming the basis of rational mechanics. Such a reduction appears to be incompatible with the classical definitions of fundamental mechanical principles, and this investigation takes the form of finding whether the latter express the essentials of the mechanical principles or whether they are really nothing more than a particular modification. The principle of inertia as also that of equality of action and reaction are not considered, since neither possesses a truly fundamental character, but only the principle of the independence of simultaneous effects and especially of the independence of the state of rest or motion. The former expresses the independent effect of each force, the latter that the effect of a force does not depend on the actual motion of the moving point to which it is applied. From the latter may be deduced that a force is never a function of the speed, but in general depends on the position of the point, *i.e.* on its co-ordinates and not on their differentials with respect to time.

The dissipation of energy, however, is manifested in all phenomena where forces of dynamic friction or viscosity are present in any degree whatever, such forces being termed passive resistances and found to be functions of the speed. The irreversible evolution of heat, inseparable from the work done by passive resistances, constitutes essentially the phenomenon of dissipation. Here appears an apparent contradiction to the principle of the independence of rest or motion, but before accepting such a conclusion as final there is need, first, to distinguish between the principle itself and the definition by which it is usually construed, and then to find whether a more general form would give a more satisfactory result.

The author begins by a critical examination of the fundamental mechanical definition of the resultant of two vectors, where the co-ordinates of the moving point are continuous functions of the time admitting first and second differentials which are also continuous functions. He notes that the accepted definition is not capable of direct verification, since our means of observation do not permit us to follow the ultimate details of motion of a material point and to discern the very small discontinuities by which it may be affected. If, then, the motion of the point considered be

supposed to undergo very small and very rapid variations, as would be the case with an irregular disturbance of small amplitude (*e.g.* the Brownian movement), it is no longer permissible to consider two neighbouring positions on the trajectory, while there is need to distinguish between the concealed movement represented by the irregular motion and its movement as represented by a displacement (apparently continuous) which may be considered as the graph of mean positions. This idea of distinction between the two movements is not original, having been proposed by Helmholtz in his researches on the second principle of thermodynamics. The author elaborately investigates the subject vectorially from the above standpoint, and substitutes for the classical definition an equivalent one, arrived at by considering three consecutive positions of the moving point separated by the same infinitesimal time-interval. The continuity is first supposed perfect, and an analytical expression for the revised definition is obtained. The case when the motion is made up of infinitesimal discontinuities is then developed, and the conclusion drawn that the motion is due, not only to the given forces, X (x, y, z), Y (x, y, z), Z (x, y, z), which are functions of the co-ordinates alone, but also to forces which are functions of the speeds, dx/dt, dy/dt, dz/dt. Under these assumptions the supposed forces, far from contradicting the principle of the independence of the state of rest or motion, are a necessary consequence of it.

The author does not suggest that his considerations give a complete solution of the problem of the dissipation of energy, but that they point out means by which difficulties may receive adequate treatment. He then considers the special case of a central force for repulsion and attraction, taking as example an electron directed towards a position of equilibrium by a central force proportional to the distance. H. H. Ho.

1016. *Molecular Agitation at Absolute Zero.* **A. Einstein** and **O. Stern.** (Ann. d. Physik, 40. 3. pp. 551–560, March 20, 1913.)—This paper presents an argument for the assumption that there is some agitation and energy of the molecules even at the absolute zero. The results of Eucken's work on the specific heat of hydrogen make the existence of the energy $h\nu/2$ at absolute zero probable. The acceptance of this value of the energy at absolute zero opens a way to derive Planck's radiation formula without the auxiliary assumptions of any discontinuities whatever. It may be noted that the *second* form of Planck's expression for the energy of a resonator runs—

$$E = h\nu/(e^{h\nu/kT} - 1) + h\nu/2.$$

This gives the energy $h\nu/2$ at zero and approaches the value kT at high temperatures. Planck's first form omitted the second term on the right. E. H. B.

1017. *Kinetic Theory and Irreversibility.* **E. Borel.** (Journ. de Physique, 3. Ser. 5. pp. 189–196, March, 1913.)—Without pretending to attain a mechanical explanation of irreversibility, the author in the present paper endeavours to point out how such a solution of the problem should be sought. E. H. B.

1018. *Black-body Radiation and Quanta Theory.* **J. de Boissoudy.** (Comptes Rendus, 156. pp. 765–768, March 10, 1913.)—Discusses the form of the probability function in the Poincaré theory of Planck's quanta hypothesis of complete radiation [see Abstract No. 341 (1912)]. [*Errata*, Ibid. p. 1198, April 14, 1913.] E. H. B.

SOUND.

1019. *Air-currents and Auditorium Acoustics.* **F. R. Watson.** (Eng. Record, 67. pp. 265–268, March 8, 1913.)—Theory and experiment are here applied to elucidate the possible influence of air-currents on the acoustical properties of the auditoriums in which, for heating or ventilation, they are made to occur. The subject was previously attacked by W. W. Jacques (Phil. Mag. 5. vol. 7, p. 111, 1879), who found that the ventilating system of the Baltimore Academy of Music was so arranged that it had a very pronounced action on the acoustics. According to the survey of Jacques, by thistle balls and anemometer, the movement of the air in the above theatre was as follows. The whole supply of fresh air was admitted at the back of the stage, was there warmed, then crossed the stage horizontally *above* the speakers, actors, or musicians, passed through the proscenium, and then, somewhat diagonally toward the roof, across the auditorium in one grand volume and with gentle motion so as to almost entirely prevent the formation of minor air-currents. It was exhausted partially by an outlet in the roof, and partly by numerous registers in the ceilings of the galleries. From this central outlet and from the large flues of the registers, the air passed into the ventilating tower over the great chandelier, whose heat supplied part of the motive power of the circulation. The acoustics of this auditorium were considered excellent. The weakest voice was audible to every seat in the house ; sounds such as a sigh, a kiss, or even the simulated breathing of the somnambulist, might be heard in the most distant parts ; and all musical effects were exactly appreciated. All singers and speakers agreed in describing the facility with which the voice was used on this stage.

The present author's theoretical examination of the above case, based on the work of Rayleigh and of Tyndall, shows that the portions of sound passing *steeply* upwards and forwards from the stage would be almost entirely transmitted into the warmer air-current overhead. On the other hand, those parts of the sound that rise but slightly in their forward motion, strike very obliquely the boundary between the cold and the warm air, and are thereat almost entirely reflected. These conclusions theoretically reached were experimentally corroborated in part by the timing of the residual sounds or resonance from an organ-pipe in a room with and without burners lit.

As to minor factors affecting the relative amounts of transmission and reflection, it is found that the more or less moisture and local slow motions of the warming and ventilating currents will have only a negligible effect. The magnitude of the reflection at the boundary of cold and warm air depends chiefly on density ratio, and therefore upon temperature difference. Haphazard currents of air or those intervening between the speaker and the audience are detrimental, and should be avoided. E. H. B.

1020. *Phonographic Investigations of Consonants.* **L. Réthi.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 1595–1609, Oct., 1912. Communication from the Phonogramm-Archivs-Kommission.)—This work forms part of an endeavour to make phonograph records legible, it being desired if possible to establish the wave-forms for each letter of the phonetic alphabet. In the research the experimental arrangement of F. Hauser was adopted, both glass and ebonite diaphragms being used. A number of consonants and semi-vowels were dealt with, the following being represented in photographic reproductions :—H, L, M, N, R, P, T, K, F, Ss, Sch, Ch (forward and backward). E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1021. *Equilibrium between Oscillators, Free Electrons, and Radiant Heat.* **M. Planck.** (Preuss Akad. Wiss. Berlin, Ber. 18. pp. 350–363, 1913.)—A mathematical and physical treatment of the subject on the basis of the author's quantum hypothesis of the second form in which the *emission only is discontinuous*; the absorption of radiation and the free propagation of electromagnetic waves *in vacuo* follow Maxwell's equations. After an introduction and statement of the physical assumptions, expressions are obtained for (i) the energy of the vibrations of the oscillators, (ii) the energy of free electromagnetic radiation, (iii) the energy of free electrons. Equilibrium conditions and irreversible phenomena are dealt with at the close. [See Abstract No. 1016 (1912).] E. H. B.

1022. *Electromagnetics and Relativity.* **S. J. Barnett.** (Science, 37. pp. 560–561, April 11, 1913.)—A defence of the author's position against the opinion raised by A. L. Kimball. [See Abstract No. 210 (1913).] E. H. B.

1023. *Atmospheric Potential.* **E. MacLennan.** (Nature, 90. pp. 647–648, Feb. 13, 1913.)—Calls attention to the paradox that in spite of a potential gradient of 100 volts per metre there is no current in a vertical conductor in the earth's electrostatic field. E. E. F.

1024. *Horned Lightning Conductors and Related Phenomena.* **H. Greinacher.** (Deutsch. Phys. Gesell., Verh. 15. 5. pp. 123–133, March 15, 1913.)—The usual explanation given of the action of horned lightning conductors is, that at the narrowest part the lighted arc is forced upwards mainly by the action of hot air, and, it attains such a length on reaching the horns that it is extinguished. This explanation is unsatisfactory. One is now given in which the action is considered as mainly electromagnetic, and experiments are described to show that this is the true explanation of the phenomenon. Experiments are also described in which the discharge is produced by weak currents, and photographs are given illustrating the results obtained at low pressures. A. E. G.

1025. *Atmospheric Electrification during Dust-storms.* **V. H. Jackson.** (Nature, 91. p. 213, May 1, 1913.)—It is found that at Patna in North India westerly winds, which occur in the daytime from the middle of March till June and raise a great deal of dust, are associated with a large negative potential gradient. On one occasion a negative gradient of about 1650 volts/m. was measured. The author concludes that probably from 9 a.m. to 6 p.m. on the majority of days from March to June the potential gradient over a large portion of Northern India is negative and very large. This association of negative potential gradient with dust-storms is similar to that found by Rudge in South Africa [see Abstract No. 657 (1913)]. J. S. Di.

DISCHARGE AND OSCILLATIONS.

1026. *Ionisation of Potassium Vapour by Ultra-violet Light.* **S. H. Anderson.** (Phys. Rev. 1. Ser. 2. pp. 233–236, March, 1913.)—The general method of determining the ionisation of potassium vapour by ultra-violet light consists in measuring the current produced between two electrodes which are placed in a highly exhausted tube containing K-vapour, when a given p.d. is applied across the electrodes and a beam of ultra-violet light is passed through the vapour between the electrodes. The minimum current observed at a temperature of 55° C. is $1{\cdot}5 \times 10^{-12}$ amp., which is an order of magnitude quite different from the currents due to ionisation of any other vapour or gas by ultra-violet light. When the tube is maintained for some time at 55° C. an increase occurs in the conductivity which is not easy to explain, and it is further observed that a current of the same order can then be obtained at room temperature, although before heating no current at all could be detected. It is suggested that this increase in ionisation is due to the addition of traces of foreign gas. A. E. G.

1027. *Mobility of Ions in Dense Media.* **H. J. van der Bijl.** (Deutsch. Phys. Gesell., Verh. 15. 6. pp. 210–218, March 30, 1913.)—A continuation of previous work [see Abstract No. 108 (1913)]. A new method was used to determine the distribution of the ions between two plates between which there was a strong field. The distribution curve was then used to determine the ionic mobilities. If t_0 is the point where the curve cuts the time axis, P the difference of potential between the plates and d the distance apart, then the mobility u is given by $u = d/t_0 P$. This formula gives the mobility of the positive or negative ions according as the field is positive or negative. Experiments were carried out with hexane and carbon tetrachloride. For hexane the mobilities of the positive and negative ions were found to be $5{\cdot}70 \times 10^{-4}$ and $4{\cdot}07 \times 10^{-4}$(cm./sec.)/(volt/cm.). The corresponding values obtained by Jaffé were $6{\cdot}03 \times 10^{-4}$ and $4{\cdot}17 \times 10^{-4}$. For carbon tetrachloride the values were $2{\cdot}44 \times 10^{-4}$ and $2{\cdot}42 \times 10^{-4}$, which are in fair agreement with the value $2{\cdot}28 \times 10^{-4}$ previously obtained by the author. A. W.

1028. *Ionisation produced by Heated Salts.* **C. Sheard.** (Phil. Mag. 25. pp. 370–389, March, 1913.)—Experiments were made with CdI_2 heated to various temperatures up to the melting-point 402° C. The salt was heated in a tube A connected to a tube B, and it was shown that there could be a large ionisation in B even with a saturation potential in A. This suggests that the ionisation is partly due to the vapour. It was found that on heating the original salt there is a large negative emission and practically no positive. As the heating continues the positive ionisation increases to a maximum and then falls away; the negative continually diminishes. Further experiments showed that iodine alone gives large currents when heated, and a comparison with CdI_2 showed that some, at least, of the negative ionisation effects are probably due to the subsequent ionisation of the iodine vapour which is liberated by chemical dissociation in visible quantities. E. M.

1029. *Photoelectric Emission of Electrons from Calcium.* **R. Pohl** and **P. Pringsheim.** (Deutsch. Phys. Gesell., Verh. 15. 5. pp. 111–122, March 15, 1913.)—The results obtained with Mg and Al have already been given [see Abstract No. 1412 (1912)]. Ca is now found to possess for the wave-length

interval 230 to 700 $\mu\mu$ a normal photoelectric electron emission, *i.e.* the number of electrons emitted per unit of absorbed light-energy is independent of the orientation of the electric light-vectors. The curve, which shows the number of electrons emitted per calorie of light energy as function of the wave-length, has a maximum between 300 and 400 $\mu\mu$. The maximum with equal light absorption occurs so much the sharper the smaller the angle of incidence of the light. The reason for this is, that in the ultra-violet where the light penetrates deeply into the feebly reflecting Ca, only a very small proportion of the liberated electrons are able to escape from the metal, while when the light is absorbed in a relatively thin layer the greater part of the electrons set free escape from the surface of the metal. It is shown that the maximum with Ca cannot be identified with the resonance maximum of selective photo-effects. [See also Abstract No. 1032 (1913).] A. E. G.

1030. *Photoelectric Properties of Thin Platinum Films.* **J. Robinson.** (Phil. Mag. 25. pp. 115–132, Jan., 1913.)—A further study of the effect described by Stuhlmann [see Abstracts Nos. 260 (1911) and 1408 (1912)], with especial regard to the critical thickness of the film for which the photoelectric current and the velocities of the electrons are the same on the incident and the emergent sides. It is found that this happens at the same value of the thickness in both cases. The dissymmetry for velocities is not so strongly marked as for currents. As the thickness of the film increases through the value 10^{-7} cm., the photo-current increases suddenly. The ratio of emergent to incident current is constant for films thinner than 10^{-7} cm., and begins to diminish after the sudden increase in current has set in. Radiations from the spark produce much quicker electrons than those from the arc. The dissymmetry is more strongly marked the quicker the electrons produced. It is shown that it is possible that photo-electrons possess sufficient energy to ionise molecules of platinum, and that it is this which leads to the best explanation of the sudden rise of the photo-current at 10^{-7} cm. The thickness of film which gives the sudden rise of current is the same for slow and quick-moving electrons. The orientation of the plane of polarisation of the light has no influence on the dissymmetry. E. E. F.

1031. *Formation of Nuclei in Gases by Ultra-violet Light.* **F. Bortini.** (N. Cimento, 5. Ser. 6. pp. 101–118, Feb., 1913.)—Repeating the experiments of C. T. R. Wilson and of Sachs [Abstract No. 918 (1911)], but filtering the gases through asbestos, and avoiding rubber connections, the author finds that, contrary to these investigators, even much beyond the ratio $v_2/v_1 = 1{\cdot}38$ no formation of cloud occurs. Ammonia forms nuclei having a radius of $8{\cdot}7 \times 10^{-7}$ cm., and air containing CS_2 nuclei with a radius of $5{\cdot}95 \times 10^{-7}$ cm. No nuclei are produced with nitrogen in presence of water-vapour, and no hydrogen peroxide could be detected in this case, even after prolonged exposure to ultra-violet light. The results obtained support Lenard and Ramsauer's conclusions that the formation of cloud is due to the production of solid chemical compounds by the action of the light. W. H. Si.

1032. *Selective Photo-effect in Relation to Absorbed Light-energy.* **R. Pohl and P. Pringsheim.** (Deutsch. Phys. Gesell., Verh. 15. 6. pp. 173–185, March 30, 1913.)—In the previous experiments carried out to investigate the selective photo-effect of the alkali metals the authors have considered the number of electrons generated per unit of *incident* light-energy as a function of the wave-length [see Abstract No. 1749 (1910)]. The object of the present

experiments is to determine the relation between the number of electrons liberated per unit of *absorbed* light-energy and the wave-length. It is found that the resonance maxima of the selective photo-effects for K and Na become much more pronounced, in comparison with the simultaneously present normal effect, so soon as the number of liberated electrons per unit *absorbed* light-energy is considered as a function of the wave-length. The resonance regions of the selective photo-effects coincides with the regions of higher optical reflection. The total charge carried by the electrons, emitted on account of the absorption of one calorie light-energy, amounts to in the middle of the resonance regions for K about 50×10^{-4}, and for Na about 120×10^{-4} coulomb. These values are considerably increased for the coloured colloidal modifications, so that for both K and Na the charge amounts to about 350×10^{-4} coulomb/cal., and gives resonance curves of a sharpness which have not previously been observed in unpolarised light. The influence of the colloidal state cannot in this case be ascribed to increased absorption of light, but the cause must be looked for in the extremely small diam. of the metal particles. A. E. G.

1033. *Presence of Helium in the Gas from the Interior of an X-Ray Bulb.* **W. Ramsay.** (Chem. Soc., Journ. 103. pp. 264–266, Feb., 1913.)—In a previous note [Abstract No. 1738 (1912)] the author stated that the residual gas extractable by heating the glass of an X-ray bulb contained a measurable trace of He, in which the Ne spectrum could also be identified. In the present paper the experiment is described in more detail, and the result confirmed as follows: The exit tube of an old X-ray bulb was connected by means of thick-walled rubber tubing with a Töpler pump, the drawn-out end of the exit tube having previously been scratched with a glass knife so that it could be broken through the rubber by the help of pliers. Before this was done, all air was pumped out of the connecting tube. The X-ray bulb stood in an air-bath of asbestos card, and was heated to about 350°. After a c.cm. of pure oxygen had been admitted to "wash" out the X-ray bulb the gases were pumped off and placed in contact with charcoal cooled by liquid air in order to condense out all gases except H, He, and Ne. The residual gas then gave the spectrum of He, the two stronger red lines of Ne also being visible. This process was repeated with two more X-ray bulbs, and the volume of the combined residual gases was 0·39 mm.³. Test experiments were tried which showed that the effect was real, and that the gas was not derived from any air which might have leaked in. E. M.

1034. *Experiments on the Electrical Discharge in Helium and Neon.* **H. E. Watson.** (Cambridge Phil. Soc., Proc. 17. No. 1. pp. 90–107, Feb. 14, 1913.)—This investigation, which is of a preliminary nature, had as its original object the determination of the kathode-fall and minimum potential necessary to produce a spark between two electrodes in all inactive gases. Measurements have been made of the spark potentials, at different pressures, between plane Al electrodes in very pure helium and neon, no external exciting agent being used. With electrodes 15 mm. apart the normal minimum spark potentials, excluding a lower value obtained on the first passage of the current, are found to be 184 and 200 volts for He and Ne respectively, the corresponding pressures being 2·4 and 2·8 mm. respectively. For a perfectly uniform field the p.d.'s might possibly be 2 or 3 volts less. At pressures higher than these the curve connecting spark potential and pressure does not assume a linear form until the pressure rises to about 10 mm. After this point the

gradients are 30 volts per cm. pressure for He, and 22 volts per cm. for Ne The kathode-fall with Al electrodes which have been well "run" is at most 164 volts for He and 170 volts for Ne. Consequently, it does not appear to be equal to the minimum spark potential. With a kathode of sodium-potassium alloy in Ne the minimum spark potential is near to and not greater than 145 volts, and the kathode-fall is 85 volts. The kathode-fall in Ne with kathodes of Cu, C, Mg, and Ca is approximately 221, 217, 150, and 150 volts respectively. Four abnormal and alternative forms of discharge are observed: (*a*) Corresponding to a state of very high resistance in the gas under examination; (*b*) a variation of this corresponding to a transition stage between it and the normal discharge; (*c*) an intermittent discharge, the frequency of which can be controlled; and (*d*) corresponding to the discharge from a Wehnelt kathode. The fatigue of the electrodes is found to be considerable and of two kinds. Firstly a true fatigue, and secondly a reluctance to allow the current to start a second time when one discharge has already passed. Measurements made on the efficiency of the light from the negative glow show this to be less than was to be expected. Peculiar physiological effects corresponding to arc blindness are also observed. A. E. G.

1035. *Disruptive Discharge due to the Combined Action of Two Striated Positive Columns.* **A. Wehnelt.** (Deutsch. Phys. Gesell., Verh. 15. 5. pp. 140–142, March 15, 1913.)—The discharge tube used is Y-shaped, having two kathodes, one on each of the arms, the anode being placed at the end of the third branch. It is arranged that one kathode can be adjusted at will. When the movable kathode is placed so that the striations of both systems exactly coincide, a steady striated positive column is seen in the common portion of the tube, and the discharge is continuous, as is indicated by a telephone and rotating mirror. When the striations due to one arm fall exactly between those due to the other arm a disruptive discharge occurs in the common branch. The telephone in circuit gives a very high note, and the rotating mirror indicates that the striations follow each other exceedingly rapidly. On this account, to the naked eye, the positive column appears almost unstriated. These experiments succeed equally well for all pressures at which a clearly defined striated column is obtainable. A. E. G.

1036. *Presence of Neon in Hydrogen after Passage of Electric Discharge through the latter at Low Pressures.* **J. N. Collie** and **H. S. Patterson.** (Chem. Soc., Journ. 103. pp. 419–426, March, 1913.)—This communication is divided into two parts, as both authors independently approached the problem from different points of view. Some years ago Collie noticed that many minerals, notably sodalite and fluorspar, change colour when bombarded by kathode rays; at the same time much gas is given off. He had also noticed that neon was present in the gas emitted from calcium fluoride under the action of the kathode rays [see Abstract No. 1738 (1912)]. It is found to be excessively difficult to get calcium fluoride in a condition so as to give no gas when bombarded by kathode rays. As this gas consists almost entirely of carbon monoxide, hydrogen, oxygen, and a trace of silicon fluoride, it had presumably been formed from the calcium fluoride, water, and carbonaceous matter in the tube. The above mixture of gases is sparked, then treated with liquid air and charcoal, and the residue, which contains neon, forced up into a capillary tube, where its spectrum can be obtained. In all, 35 experiments, some of which are described, have been carried out for the purpose of investigating this point, and neon was found every time. The investigation

was undertaken by Patterson with the object of endeavouring to verify certain deductions from the formula for electronic mass, $m = 2e^2/3a$. Since the electric charge on the α-particle is twice that on the hydrogen ion, while their masses are in the ratio of 4 to 1, it follows that the radius of the seat of the major part of the mass of an atom may be the same in each case. If therefore, by means of the electric discharge, a second electric charge could be given to the seat of mass of the hydrogen ion, an α-particle might be produced, in which case it would be possible to convert a hydrogen atom into one of helium. One way of attempting to verify these deductions seemed to be to subject hydrogen at a low pressure to the electric discharge, and, after removing the excess of hydrogen, to examine the residue in a small spectrum tube. The facts obtained as the result of the combined experiments appear to be as follows:—Neon cannot be obtained from either the glass or the electrodes by heating alone. The neon found is not due to air leaking in during experiment. Glass, either when heated to near its softening point, or under the action of kathode rays, is not permeable to ordinary neon or helium. The hydrogen and the oxygen used did not contain neon.

The explanation of these facts remains an open question. A. E. G.

1037. *Dynamical Characteristics of the Wehnelt Valve Tube.* **R. A. Porter.** (Ann. d. Physik, 40. 3. pp. 561–601, March 20, 1913. Extract of Dissertation, Göttingen.)—It is found that the lighting tension, for a given pressure and frequency of alternating current, is apparently a constant for the tube, which shows that it is independent of the glow temperature of the kathode. It decreases with increasing pressure and is influenced by the nature of the gas contained in the tube, the lighting tension for air being the highest, then that for hydrogen and oxygen, and finally that for air containing mercury vapour. It increases with increasing frequency. The statical and dynamical characteristics of the tube have been measured. The alteration of the dynamical characteristic is investigated when tension, resistance, kathode temperature, pressure, frequency, and nature of the contained gas are separately varied. It is found that this characteristic shows marked hysteresis effects. An explanation of the phenomena based on the ionic theory is put forward.

A. E. G.

1038. *Electrical Vibrations associated with Thin Rods.* **H. M. Macdonald.** (Phil. Mag. 25. pp. 427–428, March, 1913.)—In reply to Rayleigh's treatment of this case [see Abstract No. 667 (1913)], the author puts forward the view that the disturbance in the immediate neighbourhood of the free end that gives rise to the radiation in question appears to be of the same kind as in the electrical discharge from a conductor with a sharp point on it. E. H. B.

1039. *Propagation of Hertz Waves along Metal- and Liquid-surfaces.* **F. Erb.** (Jahrbuch d. drahtlosen Telegraphie, 6. pp. 521–541, March, 1913. Extract from Dissertation, Braunschweig.)—The author investigates the propagation of Hertz electric waves along the surface of metal and of salt solutions. The apparatus is carefully described. To determine the direction of the incident radiation a special receiver is used consisting of five simple receivers mounted parallel to each other on a glass plate with the thermocouples connected in series. The wave-length employed is 16·7 cm. The experiments show that the radiation is partly reflected at the edges of the metal path, and that in consequence the radiation follows along the surface of a metal path bent in its own plane. Around the surface of a metal

cylinder the radiation energy falls off in a manner which agrees tolerably with the Poincaré-March formula. Along the surface of salt solutions the radiation energy falls off much more quickly than theory requires. T. P. B.

1040. *Effect of Functions on the Propagation of Electric Waves along Conductors.* **Rayleigh.** (Roy. Soc., Proc. Ser. A. 88. pp. 103–110, Feb. 24, 1913.)—An experiment of Hertz suggests to the author some interesting problems in electric-wave propagation. In its original form waves of the simplest kind travel in the positive direction, outside an infinitely thin conducting cylindrical shell which comes to an end at a given plane. Coaxial with the cylinder a rod or wire extends to infinity in both directions. The conductors being supposed perfect, it is required to determine the waves propagated onwards beyond the cylinder on the positive side of the plane, as well as those reflected back outside the cylinder and in the annular space between the cylinder and the rod. To bring the problem within the scope of approximate methods an external coaxial conducting sheath is introduced extending to infinity in both directions, the diam. of the sheath being small in comparison with the wave-length of the vibrations. Equations are then derived, in the first place for waves in two dimensions, and some of these are found to be identical with those which apply in two dimensions to aerial vibrations executed in spaces bounded by fixed walls. The analogy throws light upon the question under what circumstances electric waves are guided by conductors. Some high authorities regard such guidance as ensuing in all cases as a consequence of the boundary condition fixing the direction of the electric force, but in acoustics, though a similar condition holds good, there is no guidance of aerial waves round convex surfaces, and it follows there is none in the two-dimensional electric vibrations under consideration. Near the concave surface of walls there is in both cases a whispering-gallery effect. The extreme case of Hertz's problem (as modified) is next considered, viz. when all the radii of the cylindrical surfaces concerned become infinite, followed by the other cases. The success of the method used in the problems depends upon the assumption of a great wave-length, which, while constituting a limitation, has the advantage of eliminating the irregular motion at the junctions. H. H. Ho.

1041. *Hertzian Oscillations from Kathode.* **K. Birkeland.** (Comptes Rendus, 156. pp. 879–881, March 17, 1913.)—Electrical oscillations are found to be produced by the intermittent discharge emanating from isolated spots on the kathode of a Crookes tube. E. H. B.

1042. *Emission of Particles by Heated Silver.* **D. M. Shaw.** (Nature, 90. p. 594, Jan. 30, 1913.)—Discusses the effects of heated silver in contact with surfaces of porcelain, plaster of Paris, etc. E. M.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1043. *Electric Conductivity of Glass and Rock Crystal.* **R. Ambronn.** (Phys. Zeitschr. 14. pp. 112–118, Feb. 1, 1913.)—It was found necessary to use polarisable electrodes of burnt-in platinum. On account of electrolysis the current was made alternating through the specimen, but was measured as direct current on account of the small e.m.f. necessary. It is shown that the law of constant equivalent conductivities of dilute solutions is applicable

to the constituents of the glass. Constants are evaluated for Na_2O, CaO, and SiO_2. The results obtained with rock crystal show that whatever electric conductivity there is is due to sodium ions, which are only capable of moving along the principal axis. Conduction is, therefore, only obtained if parts of the platinised surfaces serving as electrodes are joined by conducting filaments parallel to the principal axis. E. E. F.

1044. *The Effect of Magnetic Fields on Resistance.* **C. W. Heaps.** (Phil. Mag. 24. pp. 813–819, Dec., 1912.)—The author in a former paper described experiments on the resistance of iron, nickel, cadmium, and Heusler alloy in transverse and longitudinal fields. The present paper gives an account of experiments undertaken to find whether it is a general rule in all para- and dia-magnetic metals for a transverse field to produce a greater effect than a longitudinal, and natural crystals were specially investigated. The following are the results arrived at :—(1) For para- and dia-magnetic metals a transverse field produces a greater increase of resistance than a longitudinal field, and for small magnetising forces the increase is proportional to the square of the field strength. (2) Crystals of lead sulphide in a magnetic field behave like an isotropic para- or dia-magnetic metal. (3) The resistance of iron pyrites is unaltered by a magnetic field, and the change, if any, is less than 2×10^{-5} per ohm for a field of 10,000. (4) Whatever the direction of the magnetising force the resistance of molybdenite decreases. (5) The behaviour of magnetite in a magnetic field indicates that it has a very complex internal structure. For fields over 4000 or 5000 after saturation dR/R and H are always connected in a linear relation. This indeed appears to be a general rule in high fields. For a non-magnetic substance crystallising in regular form the internal structure may have no effect on the change of resistance in a magnetic field, but for ferro-magnetic metals the crystalline character may play an important part, since the orientation of the minute crystals may influence the general change of resistance caused by magnetisation. J. J. S.

1045. *Determination of High-frequency Resistance.* **L. Högelsberger.** (Deutsch. Phys. Gesell., Verh. 15. 5. pp. 167–170, March 15, 1913.)—The author determines the resistance of a secondary oscillation circuit coupled to a primary by inserting two inductionless resistances in the circuit and determining the resonance deflections of the galvanometer, first when there is no added resistance, and then in the two cases when the resistances are inserted in the circuit. T. P. B.

1046. *Resistivity of Metals.* **E. F. Northrup** and **V. A. Suydam.** (Frank. Inst., Journ. 175. pp. 153–161, Feb., 1913.)—Observations were made on the resistivity of Cd, Pb, Sn, Zn, Bi, and Sb, at various temperatures from about 20° C. to near the boiling-point of the substance. The results are given in curves and a series of tables, but a description of the method of investigation is deferred till a subsequent paper. J. J. S.

1047. *Influence of Temperature and Pressure on the Electrical Resistance of Metals.* **E. Grüneisen.** (Deutsch. Phys. Gesell., Verh. 15. 6. pp. 186–200, March 30, 1913.)—The more important points in this paper are as follows :—The electrical resistance of pure metals increases at very low temperatures proportionally to a universal function of $T/\beta V_m$, where V_m is determined by the atomic heat, and β is the known constant h/k of Planck's radiation theory.

The reasons for the adoption of this function, in place of that calculated by Wien for resistance, are given. The assumption made by Wien, that the number of collisions between electrons and atoms, or the reciprocal free path, is proportional to the square of the atomic amplitude, receives support. The electrical resistance of pure metals in sign and order of magnitude under the influence of hydrostatic pressure is considered, as is also the pressure effect upon alloys. A. E. G.

1048. *Dielectric Constant of Air at High Pressures.* **A. Occhialini** and **E. Bodareu.** (N. Cimento, 5. Ser. 6. pp. 15–40, Jan., 1913.)—The dielectric constant of air has been measured at pressures up to 175 atmos., the results obtained being—

Pressure (atmos.) ...	60	95	115	140	150	175
D.....	1·0357	1·0567	1·0684	1·0839	1·0903	1·1053

which agree well with those of Tangl [Abstract No. 1565 (1907)], and the values found for refractive indices by Magri [Abstract No. 1912 (1904)]. The ratio $(D-1)/(D+2).(1/d)10^6$ is almost constant, varying only between 194 and 196, but the expression $(D-1)/d.10^6$ tends slightly to increase with the density. W. H. Si.

1049. *Study of Resistance of Carbon Contacts.* **A. L. Clark.** (Phys. Rev. 1. Ser. 2. pp. 50–55, Jan, 1913. Electrician, 71. pp. 262–263, May 23, 1913.)—During some experimental work with telephone transmitters, it was found that the resistance of carbon contacts varied not only with pressure and current, but also with time and in a very regular manner. This paper is an account of an investigation of the time relations of changes in resistance in carbon contacts such as are commonly used in telephone transmitters. Experiments were made on carbon in the form of grain, balls, and plates, always with the same results. Loose contacts were studied first. It was found that when a small current was sent through such contact there is a very regular decrease in resistance, which seems to be permanent if the contact is not disturbed. The slightest jar disturbs the contact in such a way that the phenomenon repeats itself. If a strong current is followed by a weak one, the weak one has no effect on the resistance. It is not certain that there is no recovery from this change of resistance, but there is no experimental evidence to show that such recovery occurs. The sensitiveness of a loose contact to change in pressure is remarkable. It was found that shifting the weight from one foot to the other distorted the floor and table sufficiently to change the pressure and show a decided effect in the milliammeter. The table below shows the results of several successive runs beginning with a low e.m.f. and increasing to a value below the critical point. After the first run, the resistance changes very little.

Volts.	Resistance.			
0·4	445	308	296	296
0·6	383	289	287	277
0·8	254	222	236	236

When the e.m.f. passes a certain critical value the phenomenon changes. The resistance increases regularly with time. The critical value depends

somewhat on the contact pressure as previously noted by Bidwell. It also depends upon contact area, so that the critical value probably depends upon current density rather than applied e.m.f. The higher the current density, the more rapid is the rise in resistance. The resistance rises rapidly at first and then more slowly. If the current be interrupted at any time and the circuit be left open for an hour or two and then closed, the resistance begins with the same value as when the current is interrupted and the curve is continuous unless the contact has been jarred. With large e.m.f.'s but still so small that no arc forms, the resistance rises rapidly to infinity. The phenomena are totally different when the pressure becomes great enough to break down the non-conducting layer.

From the table given below, it is doubtful whether in the case of tight contact, there is a change in resistance with time.

Time. Minutes.	Volts.								
	0·06	0·21	0·4	0·56	0·72	0·83	1·09	1·60	1·9
0	4	3	2·9	3·4	3·2	2·82	2·66	1·54	1·29
½	4·8	3	2·9	3·38	3·18	2·77	2·68	1·55	1·23
1	4·4	3	3·2	3·3	3·25	2·99	2·6	1·54	1·23
1½	4·2	3	3·3	3·28	3·25	2·88	2·6	1·50	1·25
2	4·4	3	3·28	3·33	3·22	3·03	2·55	—	—
2½	—	—	3·27	3·34	3·22	2·92	—	—	—
3	—	—	3·26	3·34	—	—	—	—	—

In some cases of tight contact it has been found that the resistance decreases with time, but if the current be interrupted for a few minutes the resistance has a much smaller value than when the current was interrupted. The paper is accompanied by four curves. H. H. H.

1050. *Rectification by Photoelectric Cell.* **S. H. Anderson.** (Phys. Rev. 1. Ser. 2. pp. 222–232, March, 1913.)—An experimental research yielding the following results:—(1) The rectifying power of a photoelectric cell, using potassium for the active electrode, was found to be of the ratio 2000 to 1. (2) The general form of the rectified cycle is the same for the different pressures, electrode distances and potentials used. (3) The amount of the current for a given potential depends on the pressure of the gas, the electrode distance, and the intensity of light falling on the cell, but does not increase continuously with increasing intensity. (4) Nitrogen at a pressure of about 5 mm. combines with potassium or is absorbed by it when a glow discharge passes. (5) The high power of rectification and the high resistance of the photoelectric cell indicate that it may be very efficient as a detector of electric waves. [See Abstract No. 482 (1913).] E. H. B.

1051. *The Thomson-effect.* **H. R. Nettleton.** (Phys. Soc., Proc. 25. pp. 44–64; Discussion, pp. 64–65, Dec., 1912.)—When a current of electricity passes down a conductor in which a temperature gradient is maintained, the stationary value of the temperature at any place is dependent to a small extent on the direction of the current, for heat is evolved or absorbed in accordance with the Thomson-effect. The relation between the heat evolved or absorbed, the temperature gradient and the current was expressed by

Kelvin in the form $dQ = C\sigma \, . \, d\theta$, where dQ = heat evolved or absorbed per sec. by a current C in passing between two sections differing in temperature by $d\theta$, σ being the specific heat of electricity. An investigation was made by the author of the distribution of temperature down a conductor conveying an electric current and at the same time moving uniformly through two fixed temperature sources. The effect of the Thomson heat on the distribution is exactly similar to the effect of a small impressed velocity. Thus in the case of mercury the Thomson-effect is measured by comparing the alteration of temperature $\Delta\theta_1$, at a point near the middle of the gradient caused by reversing a current of C amps. with the alteration of temperature $\Delta\theta_2$ at the same point due to a flow of mercury of m gm. per sec. It is shown that without any approximation as to emissivity loss or magnitude of Joulian heat, $2C\sigma/ms = \Delta\theta_1/\Delta\theta_2$, where s is the specific heat of mercury and σ the specific heat of electricity. With currents of from 4 to 9 amps. and with various flows (not exceeding 1 cm. per hour) consistent values of σ were obtained, the value at 61° C. being $-1{\cdot}52 \times 10^{-6}$ cals. per 1 deg. C. per coulomb. The thermo-junctions—iron and constantan—were fused through the glass tubes with inappreciable distortion. J. J. S.

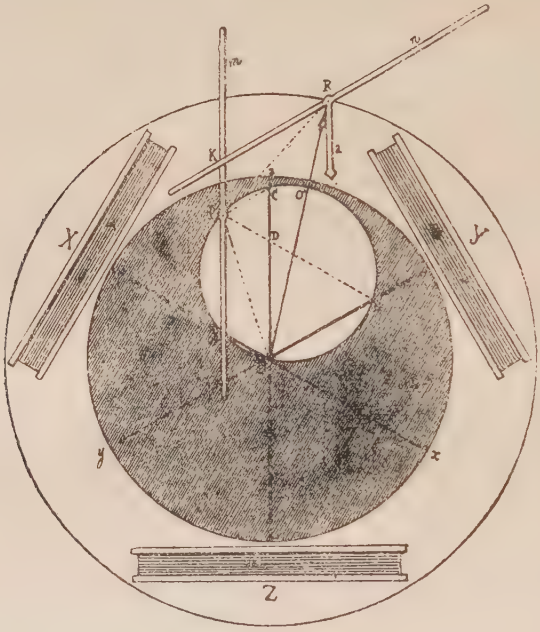
1052. *Calibration of a Thermo-couple Arrangement.* **S. Loewe.** (Jahrbuch d. Drahtlosen Telegraphie, 6. pp. 451–458, Feb., 1913.)—It is shown that the deflections of the galvanometer in a thermo-couple-galvanometer arrangement, such as is used for high-frequency work, are not always truly proportional to the square of the currents. Arrangements for calibration both with continuous and with alternating current are described. The accuracy of the calibration is 1 in 1000. T. P. B.

1053. *New Construction for Quartz Mercury Lamps.* **A. Tian.** (Comptes Rendus, 156. pp. 1063–1064, April 7, 1913.)—The author has noted, in connection with the effect of ultra-violet light on water, that there exists between the chemical properties of the rays of very short wave-length ($\lambda < 1900$ Å.) and those of the other ultra-violet radiations an opposition, the latter radiations often tending to destroy the endothermic combinations produced by the first. This difference of action has recently been developed by Berthelot. It is necessary, therefore, in seeking to realise the chemical effects of the extreme radiations (ozonisation of air, peroxidation of water, decomposition of HCl, etc.), to make use of a source of these rays giving a proportion as feeble as possible of those possessing the opposite properties. Quartz mercury lamps are, on account of their convenience, always employed; for the present purpose they must be operated at low voltage, since the total emission of ultra-violet rays from this source increases enormously with the applied p.d. [Abstract No. 1716 (1911)], while the energy of the most refrangible rays ($\lambda < 1900$) varies relatively much less [Abstract No. 1357 (1912)]. The complex form of ordinary quartz lamps renders it somewhat awkward to immerse them in a liquid, especially when the source of light is required to be as close as possible to the object dealt with. The author has constructed several lamps more suitable for this purpose. The part of the lamp made of transparent quartz has the form of a test-tube. A little mercury at the bottom serves as kathode, and connection is made to this by an iron wire protected by a small tube of opaque quartz passing down the centre of the tube. The anode is a small cylinder of iron. A copper support at the top aids the cooling by conduction. The arc can be used either with direct or alternating current; in the latter case it is necessary to use two

anodes consisting of small iron plates separated by a sheet of mica, and to provide a third electrode at the glass stopper. The lamp will work in all positions, ranging from the vertical to a small inclination to the horizontal.

A. W.

1054. *Kinematic Model for representing the Current and E.M.F. in a Three-phase System.* **S. Marcucci.** (N. Cimento, 5. Ser. 6. pp. 141–144, Feb., 1913.)—The arrangement proposed is shown in the Fig., where X, Y, Z are three arrows laid on a drawing table, along the sides of an equilateral triangle, Xx, Yy, and Zz being drawn perpendicular to them, and intersecting in O. Rotating on an axis at O is a glass disc on which is gummed paper, cut in



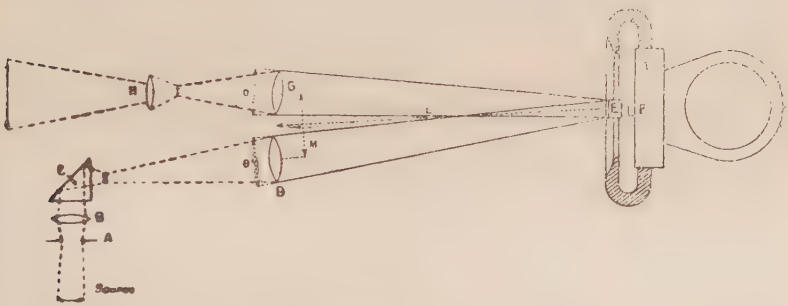
such a way that a margin is left uncovered all round, and also a circular window, whose edge passes through O. In the margin X, Y, and Z are always visible, and in the window the three segments OA, OB, and OC, these latter constituting a three-phase system, and representing not only the generating magnetic field, but also the currents themselves, and the e.m.f. The resultant magnetic field is represented by OR, obtained by producing the diameter OO′ until OR = (3/2)OO′.

W. H. Si.

1055. *Sensitive Moving-coil Galvanometer.* **H. Rohmann.** (Phys. Zeitschr. 14. pp. 203–209, March 1, 1913.)—The sensitiveness of a moving-coil galvanometer, which depends upon the size of the coil, the restoring couple, and the strength of the magnetic field, is still capable of considerable increase. An increase in the field strength leads to an increased damping, which varies as the square of the sensitiveness, and eventually leads to creeping. The author uses strong electromagnetic fields, and gives two methods of increasing the sensitiveness. In the first method, the field is

initially given such a value that the moving coil is just aperiodic. A constant current then gives a deflection corresponding to the sensitiveness. This deflection is increased by raising the magnetic field to a higher value and then allowing it to return to the former strength. During this change of field induced currents are generated in the moving coil, which is short-circuited, and these currents are strong in comparison with the original current. They first draw the pointer towards the zero and then away from it, the last deflection being the larger. The magnification of the original deflection is about half the ratio of the two fields. In the second method a ballistic throw is increased in the same ratio by starting it in a strong field, which is then suddenly reduced. The ratio of magnification obtained is 8 or 9. E. E. F.

1056. *An Interference Oscillograph.* **A. Guyau.** (Comptes Rendus, 156. pp. 777–779, March 10, 1913.)—The measurement of the movements of a telephone diaphragm led the author to construct an oscillograph of the interference type by which it is possible to record photographically vibrations of small amplitude of the order of a few hundredths of a micron. Referring to the Fig., the interference figures are formed in a thin layer of air between a movable silvered mirror F glued to the surface whose vibrations are to be investigated, and a fixed reference mirror E. The mirrors are intensely illuminated by the image of a mercury quartz lamp by means of the optical



system BCD. The image of the fringes is projected with magnification by means of the system GH, on a horizontal slit behind which is placed a recording cylinder driven by a helicoidal gear. The exact image of the fringes is thus transmitted to a sensitised surface, and forms the curve of the displacement v of the fringes as a function of the time, and the distance v of two consecutive fringes fixes the scale by which the curve represents the displacement of the moving surface. This oscillograph has been applied to study the motion of a telephone diaphragm, and enables fragments of a conversation to be recorded. The natural frequency of the telephone has also been measured with the oscillograph and found to be 800 $\sim$, and its damping (logarithmic coefficient) 400 approximately. The displacements being proportional to the intensity, the instrument can be used as an oscillograph-galvanometer. The paper gives the mathematical theory of the instrument. H. H. H.

1057. *Idiostatic Electrometer.* **V. Crémieu.** (Comptes Rendus, 156. pp. 460–463, Feb. 10, 1913.)—The author has devised a torsion electroscope to serve as a measurer of the conductivity of the air in experiments with radium. It is meant to supersede the rather unsatisfactory method of

observation depending on the rate of collapse of the leaves of a gold-leaf electroscope. A piece of Al-wire (B) is curved at one end into a circle, and at its other end dips vertically downwards; between the two extremities 4 wires of silver of $\frac{1}{50}$ mm. are stretched, whose friction against the air serves to damp the movements of the arrangement. The support consists of a metallic ribbon 25 cm. long, 0·001 cm. thick, and 0·01 cm. wide, whose upper end is fixed in a small goniometer. The ribbon is surrounded by a metal tube which carries at the same level as the movable aluminium and silver piece two pallets. The whole is insulated by a piece of amber. When charged the pallets repel the movable Al piece B, and the current is measured by observing the rate of turning of B as compared with that produced by a known current. The instrument possesses solidity and sensitiveness. In a normal atmosphere the rate of fall is about 30′ per hour, and a current causing a turning of 5° per hour can similarly be measured, and the limiting sensibility may be 10^{-13} amp. J. J. S.

1058. *New Type of Electrometer.* **B. Szilard.** (Comptes Rendus, 156. pp. 779–782, March 10, 1913.)—The author has developed a sensitive electrometer [see Abstract No. 147 (1910)] which is convenient to read, and is robust, while having dimensions comparable to voltmeters of ordinary type. The indicating needle and moving sector are in one piece, the controlling couple being furnished by a helical spring: as the moving member is not charged, it can be handled without putting the apparatus out of order or causing discharge. As a consequence, it is possible to employ a fixed scale empirically calibrated once and for all. A micrometer microscope is fixed near the scale, and this is rendered possible by the fact that the moving quadrant and index are at the same potential as the frame of the instrument. The capacity of the instrument is practically independent of the deflection, and the voltage is proportional to the charge. The sensibility of the instrument can be varied by adjustment of the helical spring. The average capacity of the instrument is about 2 cm. A current of the order of 10^{-11} amp. gives a deflection of 1 degree which is equivalent to a movement of the needle of about 0·7 mm. The paper includes a specification of the construction of the apparatus, and a number of measurements are described for which the apparatus is stated to be peculiarly applicable. H. H. H.

1059. *Torsion Electroscope in Radio-activity Measurements.* **M. La Rosa.** (Giornale di Scienze naturali ed economiche, vol. 29. Palermo, 1912. N. Cimento, 5. Ser. 6. pp. 50–60, Jan., 1913.)—Describes a new pattern of torsion electroscope of the quasi-unstable type (C. T. R. Wilson), capable of being adjusted so as to cover a wide range of potentials, and so as to present a large range of sensitiveness and be simple in use. A. D.

1060. *Conductivity of Solids.* **E. Weintraub.** (Amer. Electrochem. Soc., Trans. 21. pp. 49–67, 1912.)—Gives many useful tables compiled from data collected from various published researches. L. H. W.

1061. *Electron Theory of Metallic Conduction.* **O. W. Richardson.** (Amer. Electrochem. Soc., Trans. 21. pp. 69–92, 1912.)

1062. *The Oil-drop Method of Studying Electrical Phenomena in Gases.* **R. A. Millikan.** (Amer. Electrochem. Soc., Trans. 21. pp. 185–200, 1912.) [See Abstract No. 1745 (1910).]

ALTERNATING CURRENTS AND MAGNETISM.

1063. *Mean Magnetic Moment of a Vibrating Magnet.* **J. R. Ashworth.** (Manchester Lit. and Phil. Soc., Mem. 57. 4. pp. 1–7, March, 1913.)—A magnet is supposed to vibrate in a given plane in a constant field without friction, and an expression is calculated for its mean magnetic moment in the direction of the controlling field. Giving different values to the extreme deflection, α, of the magnet, it appears that for a value of α little more than 130° on either side, the mean moment would vanish. As the oscillations increase beyond 130° the magnet would exhibit a mean moment in the contrary sense, and would apparently behave like a diamagnetic substance. The mean kinetic energy of the vibrating magnet is calculated by a similar method, and comparison shows that the mean moment vanishes a little before the energy of vibration has reached its maximum. When the vibrations pass into rotations, the diamagnetic character will still be in evidence. When the controlling field is set up by a similar neighbouring vibrating magnet which has the same period, the diamagnetic property disappears, and the energy reaches a maximum for an angle α of about 70°. If such a pair of magnets is in rotation, the magnetic moment vanishes. The behaviour mentioned presents features which are found when the residual magnetism of a ferromagnetic substance is raised in temperature, *i.e.* there is a decline of magnetic moment with rise of temperature, and, at or near the critical temperature, the phenomenon of recalescence is found, which shows that the rate of absorption of energy on heating, or of emission of energy on cooling, is extremely large. G. E. A.

1064. *Measurement of the Work absorbed by Magnetic Hysteresis.* **G. Lignana.** (Accad. Sci. Torino, Atti, 48. No. 3. pp. 181–195, 1912–1913.)—A rapid method is described for the measurement of work used up by magnetic hysteresis, making use of a ballistic electro-dynamometer. A special electro-dynamometer has been devised for the purpose, the movable spiral of which is circular, 49 mm. in diam., and wound on celluloid, the suspension being unifilar. The fixed spiral is of wire, 0·7 mm. in diam., wound on two bobbins of hard, seasoned wood, 23 cm. in external diam., and the two bobbins have a resistance of about 60 ohms. W. H. Si.

1065. *Hall-effect at Low Temperatures.* **H. Alterthum.** (Ann. d. Physik, 40. 2. pp. 391–392, Feb. 4, 1913.)—The author refers to the work of Kamerlingh Onnes and Beckmann [Abstracts Nos. 693, 694, 695 (1913)], and gives the following table showing the values obtained by himself and by these observers :—

T	Au		Cu	
	K.O. & B.	A.	K.O. & B	A.
290° abs.	7·27	7·04	4·95	5·28
20° „	9·79	8·57	6·60	6·05

Alterthum calculated the Hall coefficient of silver, according to his theory, from the diamagnetic susceptibility to be $R_0 = 1{\cdot}10$, and in good agreement with this Onnes and Beckmann have found 1·018. J. J. S.

1066. *Distribution of Magnetic Field between the Poles of an Electromagnet.* **A. Marchetti.** (N. Cimento, 5. Ser 6. pp. 119–140, Feb., 1913.)—The author has measured the distribution of magnetic field between the poles of an electromagnet of the type used in magneto-optics, employing Corbino's method [Abstract No. 1143 (1910)] for the measurement of fields of 5000 to 16,000 units, and a slight modification of this method for feebler fields. It is found that for a given intensity of magnetisation the field on the axis of the pole space becomes greater with increase of distance between the poles, tending to equal that in the corona; and for a given distance between the poles increase in the magnetising current produces a rise in the field in the pole space, until the ratio of the latter to the field in the corona reaches a constant value (which is always less than unity). W. H. Sr.

1067. *Hall-effect in Antimony.* **J. Becquerel, L. Matout,** and [**Miss**] **W. Wright.** (Comptes Rendus, 156. pp. 463–466, Feb. 10, 1913.)—Becquerel found [see Abstract No. 1448 (1912)] that the Hall e.m.f. in Bi is much greater at the temperature of liquid air than at ordinary temperature, and is the resultant of two effects which follow different laws: one, positive in sense, proportional to the intensity of the magnetic field; the other, negative in sense, attaining to saturation. With antimony the results are as singular, but differ from those observed in the case of Bi, and are still more unexplained. The method used was that of Hall: a current was sent through a sheet 1 mm. thick and the p.d.'s at two transversal points are given for laminæ of 1 mm. traversed by 1 amp., first in a bath of oil at laboratory temperature, then in liquid air. Three sheets were examined, one cut parallel to the principal cleavage plane, *i.e.* normal to the principal crystallographic axis, and thus with the magnetic field parallel to that axis. A second sheet was taken parallel to the crystallographic axis; and a third was cut at random from a mass of antimony and is referred to as the medium sheet. It was found that: (1) the Hall-effect (positive sense) is greater at low temperatures; (2) the phenomenon depends on the orientation of the crystals in the magnetic field: the medium layer gave a notably more intense effect than either of the two others; (3) the curves giving the p.d. as a function of the magnetic field are composed of two straight lines connected by a curved portion concave to the axis of field strength. A simple decomposition into two or more effects, as in the case of Bi, is not possible in this case. The question (as also in the case of Bi) whether impurities do not produce considerable modifications is important, and further experiments are to be made with regard to this. The law of variation of the effect with the intensity of the field has not yet been sufficiently determined, and the study of a substance like Sb, in which the Hall-effect departs from proportionality to the field, is important. J. J. S.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1068. *The Apophorometer.* **J. Joly.** (Phil. Mag. 25. pp. 301–311, Feb., 1913.)—The name apophorometer signifies a measurer of sublimates. The instrument consists of a ribbon of thin Pt, about 6 cm. in length and 4–5 mm. in width, stretched between two forceps which are provided with binding screws so that a current can be sent through the ribbon, raising its temperature to any desired degree up to the melting-point of Pt. One of the forceps is movable parallel to itself, and is so acted on by a light spring that the ribbon is kept stretched. The substance to be volatilised is placed in the form of powder upon the ribbon. Beneath the ribbon a watch-glass is held in position by a movable support. When this watch-glass is in contact with the ribbon a second glass is placed on it, so that the ribbon is enclosed between the glasses for nearly its entire length. Over all a receiver fits, enabling an indifferent gas to be introduced around the heated substance, or a vacuum to be established. By raising the Pt strip to different temperatures the sublimates formed from different substances can be collected, weighed, and investigated, and in many cases a chemical analysis thus be carried out in a short time with very little material. The temperature is measured by observing the current used, the ribbon having previously been calibrated by observation of the melting of a few substances of known melting-point and observing the current necessary to obtain this temperature. Numerous examples are given of the use of this instrument in the investigation of minerals, chiefly sulphides, selenides, and tellurides. T. S. P.

1069. *Method of determining Vapour Densities at High Temperatures, and on a New Form of Quartz Manometer.* **G. E. Gibson.** (Roy. Soc., Edinburgh, Proc. 33. pp. 1–8, 1912–1913.)—The manometer described is an improved form of the membrane manometer [compare Jackson, Chem. Soc., Journ. 99. p. 1066, 1911]. The apparatus is of quartz, and is so arranged that when the pressures on both sides of the membrane are the same a quartz mirror attached to the membrane is parallel to a second, fixed quartz mirror. The position of equilibrium is determined by a lamp and scale arrangement, the manometer always being used as a zero instrument, equilibrium being attained by adjusting the external (and measured) pressure. The vapour densities of mercury vapour were determined between 437 and 912° C., the average value being 100·2, which is 1 per cent. higher than the theoretical value, 99·21, calculated on the assumption that mercury vapour is monatomic. There is, however, a slight tendency towards a decrease at the higher temperatures, so that the discrepancy may be due to slight association. [See Abstract No. 423 (1911).] T. S. P.

1070. *Improved Apparatus for measuring the Conductivity of Electrolytes.* **E. W. Washburn** and **J. E. Bell.** (Amer. Chem. Soc., Journ. 35. pp. 177–184, Feb., 1913.)—The following instructions were followed in building up a conductivity apparatus :—(1) Abandon the induction coil as a source of current and replace it by a high-frequency generator giving a pure current of a single frequency, free from the overtones present in the complex wave-system of the coil. (2) In measuring very high resistances (20,000 ohms or more)

replace the ordinary resistance box by one in which the units are free from both inductance and capacity, *e.g.* by thin films of metal. (3) Use a tuned telephone and an extended bridge wire, and make all measurements at the middle of the bridge; take as much pains in balancing the capacities in the bridge-arms as in balancing the resistances. Test measurements indicated that with the improved apparatus the conductivity of any solution of an electrolyte from conductivity water to a several-times normal solution could be determined with a precision of 0·01 per cent. with the greatest of ease, and that by careful work this degree of precision can be raised to 0·001 per cent. in most cases. The absolute values would be of a lower order of accuracy unless constant errors of 0·001 per cent. or more were all eliminated. T. M. L.

1071. *Optical Investigation of Solidified Gases.* II. *Crystallographic Properties of Hydrogen and Oxygen.* **W. Wahl.** (Roy. Soc., Proc. Ser. A. 88. pp. 61–69, Jan. 29, 1913.)—Liquid hydrogen when further cooled crystallises with great velocity in spite of the fact that the temperature is only 20° above the absolute zero. Radiating groups of needles are formed, but these are absolutely isotropic and are probably derived from forms of the cubic system. Liquid oxygen, on the other hand, becomes viscous before crystallisation sets in. The crystals formed in the viscous mass are not well developed: they grow only slowly, and altogether cease to grow if cooled too rapidly. These crystals, like the glassy material from which they separate, appeared to be isotropic, but were proved to be hexagonal with small double refraction like quartz. Cooling with liquid hydrogen causes the whole to change into a fine-grained mass of crystals, which are strongly doubly-refracting; the oxygen is therefore polymorphous. This is important, as most of the physical properties of solid oxygen have been measured at the temperature of liquid hydrogen, and are therefore those of the lower-temperature form. The vapour pressure of oxygen when the charcoal vacuum is turned off is 0·45 mm., rising rapidly to 1·11 mm. and then remaining constant for some time; the former value is probably the vapour pressure at the triple-point where two solid forms are in equilibrium with vapour: the latter is probably the value for a second triple-point, where crystals, liquid, and vapour are in equilibrium. Interest attaches to the analogy between oxygen and sulphur as polymorphous elements. T. M. L.

1072. *Chemically Active Nitrogen.* **A. Koenig** and **E. Elöd.** (Phys. Zeitschr. 14. pp. 165–167, Feb. 15, 1913.)—The authors describe experiments corroborating the views of Strutt [Abstract No. 1897 (1912)] and meeting the objections of Comte [Abstract No. 707 (1913)] concerning the existence of an active form of nitrogen. They absorbed the oxygen by means of hot copper, as proposed by Comte. It was found consistently that a progressive purification of the nitrogen, especially by removal of the oxygen, leads to a stronger and more persistent afterglow. The active modification of nitrogen probably consists of single N-atoms, whose recombination to inactive N_2 molecules is accompanied by the characteristic glow. E. E. F.

1073. *Chemically Active Nitrogen.* **R. J. Strutt.** (Phys. Zeitschr. 14. p. 215, March 1, 1913. From the English.)—In reply to Comte [Abstract No. 707 (1913)] the author describes experiments with nitrogen which forms no fog with phosphorus, but can be made to do so by adding 0·001 per cent. oxygen. With this nitrogen free from oxygen a beautiful glow was obtained. A further long passage over red-hot copper produced no difference in the

glow, but passage through a tube cooled by liquid air increased it. The author suggests that this increase is due to the condensation of impurities capable of stopping the glow, and that the presence of such impurities may account for Comte's negative results. E. E. F

1074. *Periodic System and the Radio-elements.* **A. S. Russell.** (Chem. News, 107. pp. 49–52, Jan. 31, 1913.)—It has been recognised that some of the longer-lived radio-elements, such as Ra, RaF, and RaEm, have definite places in the periodic system of the chemical elements. In the present paper the whole of the radio-elements are dealt with. The following rules are given: (1) Whenever an α-particle is expelled by a radio-element the group in the periodic system, to which the resultant product belongs is either two units greater or two units less, than that to which the parent body belongs. (2) Whenever a β-particle or no particle is expelled, with or without the accompaniment of a γ-ray, the group in the periodic system to which the resultant product belongs is one unit greater, or one unit less, than that to which the parent product belongs. E. M.

1075. *Radio-elements and the Periodic Law.* **F. Soddy.** (Chem. News, 107. pp. 97–99, Feb. 28, 1913. Nature, 91. pp. 57–58, March 20, 1913.)—The paper is an extension of the discussion given by Russell [see preceding Abstract] and deals mainly with those radio-active products which appear to be chemically non-separable. Thus the products radio-thorium, UrX, ionium, and radio-actinium in the fourth group of the Periodic Table appear to occupy a place already occupied by the element thorium, and hence are non-separable from each other and from Th. The consideration indicates that almost every vacant place in the Periodic Table between Tl and Ur is crowded with non-separable elements of atomic weight varying over several units, and leads to the presumption that the same may be true in other parts of the table. Nothing further is necessary to explain the failure of all attempts to obtain numerical relations between the atomic weights. It may thus be predicted that all the end products, probably six in number, of the three radio-active series, with calculated atomic weights between 206 and 210, should be non-separable from "lead," the element which appears to have an atomic weight 207·1

Experimental results are given which indicate that Ac is produced from UrX through an intermediate substance. **N. R. Campbell.** (Ibid. p. 85, March 27, 1913.) E. M.

1076. *Application of the Principle of Relativity to Radio-chemistry.* **R. Swinne.** (Phys. Zeitschr. 14. pp. 145–147, Feb. 15, 1913.)—Putting, with Einstein [Abstract No. 133 (1906)], the energy equivalent of 1 gm. $= 9 \times 10^{20}$ ergs, the author calculates the loss of atomic weight attributable to the energy of the expelled particles, apart from their weight. He finds that in the uranium series the energy expended in the various steps down to RaF involve a total loss amounting to 0·023 per cent. of the atomic weight. If such losses are taken into account, they may go some way towards explaining the deviations from the atomic weights required by Prout's hypothesis. In any case, they tend to compensate the amount by which the weight of the helium atom falls short of 4. E. E. F.

1077. *Decomposition of Water by α-Rays.* **W. Duane** and **O. Scheuer.** (Comptes Rendus, 156. pp. 466–467, Feb. 10, 1913. Le Radium, 10. pp. 33–46,

Feb., 1913.)—The decomposition of water in the solid, liquid, and gaseous state by the α-rays was studied. Whatever its state water is thus decomposed into O and H. In the gaseous state, as in the liquid, there was formation of H in excess, and this hydrogen in the former case attained 50 per cent. of the total volume of gas. The quantity of liquid water decomposed is proportional to the intensity of the radiation. The number of molecules of gas formed is 6 per cent. greater than the number of ions that the same α-rays would produce in air. The ratio of the number of molecules of gas formed to the number of ions produced is 1/20 for ice, and for the vapour 1/50 to 1/150 of that obtained for liquid water. J. J. S.

1078. *Electrochemical Properties of Radio-active Elements.* **K. Fajans.** (Phys. Zeitschr. 14. pp. 131–136, Feb. 15, 1913.)—From such facts as are available concerning the electrochemical behaviour of radio-active substances it is concluded that any radio-active transformation involving the expulsion of an α-particle generates an element more electro-positive than the parent element. Transformations produced by the expulsion of a β-particle, on the other hand, generate "nobler" elements. [*Errata*, Ibid. p. 257, March 15, 1913.] E. E. F.

1079. *Radio-active Elements and the Periodic System.* **K. Fajans.** (Phys. Zeitschr. 14. pp. 136–142, Feb. 15, 1913.)—The electro-chemical behaviour of the radio-active elements [see preceding Abstract] may be most simply summarised by saying that the expulsion of an α-particle moves the element two places to the left in the periodic system, while the expulsion of a β-particle, while leaving the atomic weight unchanged, moves the element one place to the right. All the known radio-active elements may then be grouped in the periodic system. The emanations are placed in Group 0. Group 2 contains AcX, ThX, Ra, and Meso-Th_1. Group 3 contains Ac and Meso-Th_2, together with a group of lower atomic weight comprising Tl, AcD, ThD, and RaC_2. Group 4 contains Radio-Ac, Radio-Th, Io, Th, and UrX, together with Pb, RaD, AcB, ThB, and RaB, each of which is two units higher than the last. Group 5 contains Bi, RaE, AcC, ThC_1, and RaC_1. Finally, Group 6 contains Ur_2 and Ur_1, with the secondary group RaF, ThC_2, RaC, AcA, ThA, and RaA. The author believes that this successful grouping of the radio-active elements confirms the supposition that the periodic system owes its origin to radio-active evolution. E. E. F.

1080. *Chemical Nature of some Radio-active Disintegration Products.* **A. Fleck.** (Chem. Soc., Journ. 103. pp. 381–399, March, 1913.)—The paper contains details of numerous experiments on the separation of mixtures of various radio-elements and other substances. It is shown [see also Abstract No. 1763 (1912)] that UrX and radio-actinium are chemically similar to and non-separable from thorium ; mesothorium 2 is non-separable from actinium ; ThB is non-separable from Pb ; RaB and AcB are extremely similar to Pb and probably non-separable from it ; ThC_1 RaC, and AcC are very closely allied to Bi and probably chemically similar to it. For the details of the methods tried the original paper must be consulted. By measurements of the direct growth of RaF from RaE the author concludes that the latter consists of one product only. RaE is shown to possess chemical properties identical in all respects with those of Bi. E. M.

1081. *Alloys of Aluminium with Vanadium.* **N. Czako.** (Comptes Rendus, 156. pp. 140–142, Jan. 13, 1913.)—A series of these alloys containing

up to 80 per cent. V have been prepared by the aluminothermic method. Microscopic analysis and the examination of residues yield definite evidence for the existence of the compounds Al_3V and AlV, while the existence of the compound AlV_2 seems probable. Up to about 10 per cent. V the alloys are malleable; above this they become more and more hard and brittle, the maximum hardness being attained at about 53 per cent. V (Al_3V).

F. C. A. H. L.

1082. *Effect of High Carbon on Charcoal Iron.* **J. E. Johnson, Jr.** (Amer. Inst. Mining Engin., Bull. No. 74. pp. 173–214, Feb., 1913. Metallurgical and Chem. Eng. 10. pp. 777–788, Dec., 1912.)—Contains an account of investigations on the properties of charcoal iron from which it is concluded that spotted irons, containing a white chilled spot in the centre of the pig are products of carbon segregation, and that this segregation may take place in irons containing either more or less carbon than the eutectic ratio; further, that the segregation is less marked and less likely to have ill-effects the further the carbon is below the eutectic ratio. It is also shown that when the fracture of an iron shows high cleavage at the edge, it is generally up to or above the eutectic ratio and is a weak iron. Close spots, not associated with cleavage, may occur in irons of good quality, especially where the silicon is comparatively high. C. O. B.

1083. *Notes on Cast-iron.* **A. Sauveur.** (Amer. Inst. Mining Engin., Bull. 75. pp. 503–524, March, 1912.)—Consists of general notes on the physical properties of cast-iron, the ultimate and structural composition, etc. Shows that a knowledge of the ultimate composition is not sufficient, and that a knowledge of the size, form, and mode of distribution of the graphite is important in relating the properties and composition. Cast-iron of maximum strength should have a eutectoid or slightly hyper-eutectoid matrix, that is, it should contain about 0·8 % combined carbon, and the graphite particles should be few in number, *i.e.* the total carbon should be low. These graphite particles should not be present as sharp long plates, but as rounded star-like particles. The formation of this form of carbon may be assisted by relatively quick cooling during and below solidification. Another important factor is Si-content, and for small castings higher Si is necessary than for large castings. It is pointed out that a knowledge of the proximate composition of cast-iron should be of greater value than a knowledge of its ultimate composition, the important proximate constituents of commercial cast-iron being: (1) elemental carbon or graphite; (2) iron carbide, Fe_3C; (3) iron silicide, FeSi; (4) iron phosphide, F_3P; (5) manganese carbide, Mn_3C; and (6) manganese sulphide MnS. The relative proportions of these constituents may readily be calculated from a knowledge of the ultimate composition. Examples are given of the methods of calculating the proximate and structural composition of cast-iron. The formation of spots of white cast-iron surrounded by grey iron receives attention and the mechanism of eutectic, hyper-eutectic, and hypo-eutectic cast-irons is described. With regard to the graphitising of cementite, it is well known that this constituent breaks up into ferrite and graphite on heating to a sufficiently high temperature; that the higher the temperature the more easily does this association take place, and that silicon promotes it. It is probable that the higher the temperature at which cementite forms, the more readily it will be converted into ferrite and graphite on subsequent cooling; and from this assumption it follows that the graphitisation of the cementite in cast-iron during and below

their solidification will take place in the following order with increasing difficulty: (1) graphitisation of pro-eutectic cementite, (2) graphitisation of eutectic cementite, (3) graphitisation of pro-eutectoid cementite, and (4) graphitisation of eutectoid cementite. [See also preceding Abstract.]
C. O. B.

1084. *Influence of High Temperatures on the Physical Properties of Alloys.* **I. M. Bregowsky** and **L. W. Spring.** (Eng. News, 69. pp. 372–374, Feb. 20, 1913. Rev. de Métallurgie, 10. pp. 111–123, Jan., 1913.)—The authors have made tests on the mechanical properties in tension and torsion of a large number of commercial metals and alloys of all descriptions (brasses, bronzes, mild steels, alloy steels, cast-iron, etc.) at temperatures up to 1000° F. (538° C.). Heating was effected by means of an electric resistance tube furnace, and the temperatures were measured by inserting a pyrometer into a longitudinal hole bored from the top of the specimen to within a short distance of the test section. The paper is accompanied by 35 diagrams showing the variation of mechanical properties with the temperature, and tables giving the complete chemical analyses of the alloys tested.
F. C. A. H. L.

1085. *Volatilisation of Certain Binary Alloys in High Vacua.* **A. J. Berry.** (Cambridge Phil. Soc., Proc. 17. 1. pp. 31–33, Feb. 14, 1913.)—The work described in Abstract No. 601 (1912) has been continued with slight modifications in the method employed. Copper and cadmium are separated quantitatively by heating at 600° C. for several hours. An alloy containing Mg with an excess of Cd gave a distillate containing both metals, but no definite relationship was established as regards composition. This pair of metals evidently belongs to Group V. of Groves and Turner's classification [see Abstract No. 1459 (1912)]. Magnesium and lead gave a distillate at 680° C., which consisted chiefly of Mg containing only little Pb. Since the compound Mg_2Pb undoubtedly exists, failure to distil it indicates that it is largely dissociated in the form of vapour.
F. C. A. H. L.

1086. *Some Properties of Industrial Electrolytic Iron.* **L. Guillet** and **A. Portevin.** (Comptes Rendus, 156. pp. 702–705, March 3, 1913.)—The electrolytic iron employed had the composition; C, Mn, Si and S–nil; P, 0·025 %; As, 0·011 %. As prepared, the metal was supersaturated with hydrogen, was brittle, and had a ball hardness of 140, which was reduced to 90 after annealing at 900° C. for 2 hours in magnesia. Determination of the critical points with a Saladin-Le Chatelier galvanometer gave the figures :—

	Heating.		Cooling.	
As prepared	791° C.	937° C.	902° C.	778° C.
After annealing	788° C.	932° C.	902° C.	778° C.

The crude metal shows a critical point between 530° and 690° C. (according to the sample) on heating, but the point is not reproduced on cooling or subsequent reheating. While A_3 is sharp, the point A_2 is a range, particularly on cooling, indicating mutual solubility of α and β iron. The specific resistance of the annealed sample was found to be 9·98 microhms-cm. after correcting for the impurities present. According to Benedicks the true value should be 7·6, showing that the present sample contained 0·008 % hydrogen in solid solution.
F. C. A. H. L.

1087. *Influence of Arsenic on the Properties of Mild Steel.* **J. Liedgens.** (Elektrotechn. Zeitschr. 34. p. 305, March 6, 1913. Dissertation from the Techn. Hochschule, Berlin, 1912.)—Fourteen alloys, containing 0·1 to 3·3 % As have been prepared from a basic open-hearth steel of the composition; C, 0·082; Mn, 0·437; P, 0·020; Si, 0·05; S, 0·051; Cu, 0·174; and As 0·034 %, and a complete study has been made of their mechanical and magnetic properties. By autogenous and electrical methods the alloys could be welded up to 1·2 % As, but only up to 0·12 % by ordinary methods. The tensile strength rises to a maximum at 1·6 % As, after which it falls again; the contraction and extension, however, are diminished continually. Arsenic exerts no apparent influence on the processes of tinning, galvanising, and enamelling. In annealed materials arsenic has no effect on the permeability, hysteresis, remanence, and coercive force, but exerts a beneficial effect on the quenched alloys from the point of view of their magnetic qualities.

F. C. A. H. L.

1088. *Why does Lag Increase with the Temperature from which Cooling Starts?* **H. M. Howe.** (Amer. Inst. Mining Engin., Bull. 75. pp. 479–485, March, 1913.)—The transformation of austenite to pearlite plus ferrite or cementite is subject to considerable lag, which increases with the rapidity of cooling, with the presence of retarding elements and with the temperature from which cooling starts. Heating to a high temperature may contribute to the increase of lag in four ways: (1) by increasing the temperature gradient between the shell and core during passage through the transformation range; (2) by increasing the internal pressure; (3) by effacing the original crystallisation nuclei; and (4) by increasing the thoroughness of diffusion and rendering more difficult the subsequent reassembly of the constituents. The author deals with these points at some length, and points out that the causes throwing the interior into compression put the shell into tension and promote the transformation, which accounts for the decreased hardness observed by various workers on increasing the temperature of quenching. F. C. A. H. L.

1089. *Electrical Conductivity and Fluidity of Strong Solutions.* **W. S. Tucker.** (Phys. Soc., Proc. 25. pp. 111–123; Discussion, pp. 123–124, Feb. 15, 1913. Electrician, 70. pp. 1182–1184, April 4, 1913. Abstract.)—Experiments were made on the conductivity and viscosity of strong solutions of calcium chloride, both isothermally with varying concentration and over a range of temperature. Smooth curves were obtained even with supercooled melted crystals. By expressing concentration as a ratio of masses (instead of by volume) giving mols. of solute per 100 mols. of solvent, a linear relation was found between the concentration n and the ratio of conductivity to fluidity, for all but the lowest concentrations. This is in agreement with similar observations by Bousfield and Lowry on solutions of sodium hydroxide. The observations at low temperatures are in agreement with those of Kunz in showing a decreased rate of diminution of conductivity, so that marked conductivity still persists at the lowest temperatures. T. M. L.

1090. *Molecular Weight and Turbulence Viscosity.* **W. Sorkau.** (Phys. Zeitschr. 14. pp. 147–152, Feb. 15, 1913.)—The law of viscous flow enunciated by Poiseuille loses its validity when the liquid flows under considerable pressure. The ordinary flow gives way to the turbulent or hydraulic flow first described by Hagen in 1854. For still higher pressures the turbulent

flow is replaced by yet another type of flow resembling the passage of a rigid filament of liquid without viscosity, with the formation of dead water at the capillary wall. The author calls this type "friction-less flow." It obeys the law $t = cVD^{1/2}p^{-1/2}$ where D is the density of the liquid and C is a constant determined by the capillary dimensions, but practically independent of the temperature. A comparison of the turbulence viscosities of acetone, ethyl acetate, and chloroform had suggested a connection between these constants and the molecular weights. In order to test this connection, the measurements were extended to the carefully purified esters propyl acetate, butyl acetate, and methyl propionate. The simple formula $C = 12{\cdot}25 \times M^{1/2}$ was obtained, which recalls Bunsen's law of flow for gases. The succession of speeds of flow for the three acetic esters examined is reversed in proceeding from turbulence to frictionless flow. Knowing that there are two different types of flow, one of them a function of the molecular weight, while the other is a function of the density, this reversal is no longer surprising. That water and alcohol in Hagen's turbulent flow are more viscous than the highly molecular chloroform may be explained by the strong association of these liquids. Some recent experiments indicate an eight-fold molecule for water, similar to that deduced by Duclaux from its expansion. E. E. F.

1091. *Solubility of Active Deposit of Thorium.* **C. F. Hogley.** (Phil. Mag. 25. pp. 330–332, Feb., 1913.)—A piece of Pt was exposed to thorium emanation for a few days so as to be coated with Th active deposit with the products ThB (10·6 hours) and ThC (1 hour) in equilibrium. The Pt was then dipped into various solutions and the loss of activity measured for the ensuing 4 hours. From the measurements the percentage of either B or C which had dissolved could be determined. It was found that water, solutions of salts, hydroxides, and acids dissolve both products, but ThB is always dissolved in a relatively larger amount than ThC. The results show that the solubility in water (boiling) is small, about 35 % being dissolved in 15 minutes' treatment. A solution of KI was found to dissolve the active deposit at more than twice the rate of water. Dilute HCl or HNO_3 has a much more rapid rate of solution even at ordinary temperatures. In the case of organic solvents the rate of solution was found to be about the same as in the case of water, but the ThC dissolves more easily than the ThB—in fact, ThB is absolutely insoluble in carbon disulphide and methylene iodide, whilst ThC is soluble to the extent of 20 % in 10 minutes. E. M.

1092. *Alteration of the Vapour Pressures of Aqueous Sulphuric Acid Solutions with the Temperature.* **C. Hacker.** (Ann. d. Physik, 39. 6. pp. 1338–1349, Dec. 23, 1912. Extract from Inaug. Dissertation, Kiel, 1912.)—Von Babo's law, which states that the ratio between the vapour pressures of an aqueous solution, p_s, and of pure water, p_w, is independent of the temperature and depends only on the concentration of the solution, is not in agreement with the requirements of thermodynamics and would, indeed, lead to the conclusion that the heat of dilution would be zero for all solutions. Since attempts to detect divergences from this law by direct measurement have given no certain results, the author has made observations on the differences between the vapour pressures of various sulphuric acid solutions and those of pure water at temperatures from 0° to 100°. The results show that von Babo's law is invalid and that the divergences from it increase with the concentration, as is required by the theory of the heat of dilution. The numbers obtained for the vapour pressures are also found to agree quantitatively with the observed heats of dilution. T. H. P.

1093. *Laws of Corresponding States.* **E. H. Amagat.** (Comptes Rendus, 156. pp. 271–277, Jan. 27, 1913.)—Various investigations have indicated that, for different substances, the expression, $E = pv/T$, has identical values at corresponding points, provided the volumes are referred to the molecular weights. This relation apparently holds for normal substances and discordant results are attributed to the influence of secondary factors, such as polymerisation. This conclusion is supported by the fact that, of 28 compounds examined, those of similar type give equal values of E in all cases excepting with the alcohols, which exhibit a tendency to polymerise. Criticisms made by Mathias (Congrès du Froid, 1912) are answered. T. H. P.

1094. *Saturation Curves and the Law of Corresponding States.* **E. H. Amagat.** (Comptes Rendus, 156. pp. 843–848, March 17, 1913.)—The author has shown previously [see preceding Abstract] that the saturation curves constructed with reduced pressures as abscissæ and the values of pv/T as ordinates—which should be coincident if the law of corresponding states were rigorously obeyed—lie within a comparatively narrow strip, showing that the deviations from the law are much smaller than has been usually thought. Further consideration of the curves and of saturation curves for other compounds, as well as of the curves connecting p and pv, leads the author to regard the law of corresponding states not merely as an approximation but as a fundamental scientific law. T. H. P.

1095. *The Law of Guldberg and Corresponding States.* **A. Leduc.** (Comptes Rendus, 156. pp. 65–66, Jan. 6, 1913.)—In discussing the relationship between the critical coefficient and molecular weight of a substance Boutaric [see Abstract No. 737 (1913)] had assumed that the boiling-points of different liquids under normal pressures were corresponding, although he knew that this assumption was not quite justified. The author suggests that the following modification of Guldberg's law would be justified: The boiling-points of substances under equally reduced pressures are corresponding temperatures. If the pressure is reduced to 1/76 of what it is at the critical temperature, *i.e.* to as many cm. as there are atmospheres, the quotient T/θ is approximately 0·6 for acids, ethyl-chloride, etc. (though only about 0·55 for N, O, CH_4, etc.) but greater than 0·6 for alcohols, water, and CO_2. H. B.

1096. *Method of determining "a" of van der Waals' Equation from the Surface Tension.* **A. P. Mathews.** (Journ. Phys. Chem. 17. pp. 154–161, Feb., 1913.)—Uncertainty still exists as to the correct value of van der Waals' constant a, which expresses the cohesive pressure of a fluid. The author's method of calculating it is based on the surface-tension formula of Young and Eötvös, $S = rK/3$ (where r is the radius of action of the cohesive attraction and K the total cohesive pressure), Rayleigh's formula $S = 3rK/20$, leading to obviously improbable values of a; further, the method, unlike those previously used, is independent of any assumption as to the value of b or of its constancy when pressure and temperature are changed. The constant a may be equated to N^2M^2K, where N is the number of molecules in the volume V, so that, if V^2 be written N^2v^2, $a/V^2 = M^2K/v^2$, where v is the volume at the disposal of a single molecule. M may be called the mass of cohesion of a molecule and K a constant of proportion. At the temperature absolute zero, when the molecules are in contact, $r = v_0^{\frac{1}{3}}$, so that $S \cdot v_0^{\frac{2}{3}} = KM^2/2v_0$. Further, according to Eötvös' formula, $S \cdot v_0^{\frac{2}{3}} = 2{\cdot}19\ (T_c - 6)/N^{\frac{2}{3}}$. Hence, assuming the value $6{\cdot}21 \times 10^{23}$ for N, $M^2K = 9{\cdot}045 \times 10^{-16}\ (T_c - 6)v_0$. From the values of M^2K thus obtained, those of a and b are readily calculable. For ether,

pentane, and isopentane, which are non-associating substances and have been very carefully investigated, the ratio $V_c : b_c$ has the values 2·078, 2·074 and 2·072 respectively. The mean of these, 2·074, agrees closely with that calculated in various ways by van der Waals, and differs considerably from the theoretical number, 3. The equations expressing the relations between these constants and the critical constants hence require modification. Thus, $a/P_c = 3V_c^2$ becomes $a/P_c = 6{\cdot}284\,V_c^2$; $P_c = a/27{\cdot}02\,b_c^2$ and not $a/27\,b_c^2$; $T_c = 7{\cdot}769\,a/27{\cdot}02\,Rb_c$, not $8a/27\,Rb_c$, etc.

In most cases the values of M^2K calculated from the surface-tension formula agree moderately well with those given by the ordinary formula, but a few appreciable differences occur, and it seems probable that the former are the more accurate. T. H. P.

1097. *New Method for determining the Diffusion of Dissolved Substances.* **L. W. Öholm.** (K. Vetenskapsakad. Nobel Inst. 2. No. 22. pp. 1–23, 1912.)—The diffusion apparatus devised by the author consists of four round slabs, which are superposed so that their central holes, 2 cm. in diam., exactly correspond; of a plain lid and a bottom slab having a central capillary nozzle connected by means of a clipped rubber tube with a pipette containing the diffusing solution. All the slabs and the lid are of brass and are ground quite smooth. The five slabs are greased and are then wiped with a fine linen cloth so that sufficient grease remains on them to ensure that the solution does not cling. The diffusing liquid is run carefully down the rubber tube so as to expel all the air and so that the capillary hole in the bottom slab is just reached. Three of the slabs are then fitted and the hollow cylinder thus formed filled with the solvent, say water, a slight excess of which rests on the top of the third slab; this excess is swept off by putting on the fourth slab, the liquid column left thus having exactly the same height as the three slabs. This column is then raised through the height of one layer by running in from the pipette, an amount of the diffusing liquid just corresponding with one layer; the extra 1 mm. thickness of the top slab is left free. Evaporation is prevented by means of the lid. The apparatus is especially useful for viscous solutions, such as aqueous glycerine solutions of lithium or potassium chloride, which would adhere too strongly to glass. Test experiments with potassium chloride solutions show that the apparatus gives reliable results.

The resistance of potassium chloride to diffusion is increased considerably by the addition of a non-electrolyte to the solution. Thus, a solution of the salt in water gives at 18° the diffusion coefficient 1·319–1·330, the value in 1·5N-sucrose solution being 0·410–0·420; in 2N-sucrose solution 0·215–0·242; and in 7·48N-glycerol solution, 0·174–0·176. T. H. P.

1098. *Diffusion of an Electrolyte in Gelatine.* **L. W. Öholm.** (K. Vetenskapsakad. Nobel Inst. 2. No. 30. pp. 1–8, 1912.)—The author has measured the electrical conductivity of solutions of potassium chloride containing various proportions of gelatine, and has also determined the diffusion coefficients for the same solutions by means of the apparatus already described [see preceding Abstract]. The results show that the electrical conductivity as well as the diffusion are appreciably less in a solution of gelatine than in pure water, the decrease being about 6 % for a 2 % gelatine solution; the degree of dissociation of the electrolyte is not, however, changed. Further, the extents to which the diffusion coefficient and the conductivity are diminished are equal for equal contents of gelatine. The

curve showing the relation between the diffusion coefficients and the proportions of gelatine present is of the same form as the corresponding curve for potassium chloride solutions containing sucrose or glycerol, so that, as a first approximation at least, a gelatinous body affects the diffusion and the conductivity of an electrolyte in exactly the same way as a non-electrolyte in general. T. H. P.

1099. *Diffusion of Silver into Glass.* **G. Schulze.** (Ann. d. Physik, 40. 2. pp. 335–367, Feb. 4, 1913. Communication from the Physikal.-Techn. Reichsanstalt.)—The diffusion of silver from fused silver nitrate was noticed by Heydweiller and Kopfermann [see Abstract No. 1374 (1910).] The experiments were made with glass tubes, open at both ends, or test-tubes, dipped into fused $AgNO_3$ or containing mixtures of K and Na nitrates; the nitrates were electrically heated. The glass is described as a Thuringian glass containing 11 per cent. of Na; but there is some mistake in the percentages given. Above 250° C. silver diffuses into the glass from the nitrate in the form of free ions, sodium ions leaving the glass. The conductivity is apparently lowered because the glass resistance rises when the glass is heated for long periods; but there is really an increase in conductivity produced by the replacement of Na by Ag. The diffusion follows the law of Warburg, the amount of silver entering being proportional to the square root of the time and to the square root of the product of the conductivity of the glass and its absolute temperature. The concentration of the silver decreases as the depth increases. Electrolysis introduces the silver more rapidly, and experiments were made with electrolysis and diffusion acting in the same and in different directions. The measurements are difficult, because the tubes always crack, and because the glass is chemically attacked by the liberated alkali: to avoid the latter effect, the test-tubes were filled with $KHSO_4$ or, better, with H_2SiO_3. Glass charged with silver appears like gold or silver in reflected light and bluish-green in transmitted light, when heated in the Bunsen flame. A formula is also given for the diffusion of silver into glass from the mixed fused nitrates of Ag and Na. **E. Warburg.** (Ibid. 40. 2. pp. 327–334, Feb. 4, 1913.)—Warburg assumes that both in electrolysis and in diffusion the positive ions alone migrate; their velocity might be calculated after Nernst, but the diffused electrolyte is not completely dissociated, and he supposes that each molecule will be dissociated and not dissociated for different periods. The theory deduced is in the main in agreement with the experiments; but it differs as to the concentration of the silver at considerable depth of the glass and as to the concentration of the silver diffusing into the glass from mixtures of silver and sodium nitrates. H. B.

1100. *Dependence of Diffusion on the Viscosity of the Solvent.* **L. W. Öholm.** (K. Vetenskapsakad. Nobel Inst. 2. No. 26. pp. 1–21, 1912.)—From Einstein's molecular kinetic equation of diffusion [see Abstract No. 1122 (1908)] it follows that the diffusion coefficients of one and the same non-electrolyte in different solvents and under otherwise similar conditions should be inversely proportional to the viscosities of the solvents, that is $k\eta = \text{const.}$ The empirical square-root equation, $k\sqrt{M} = C$, leads to the same conclusion. In both cases the solutions are assumed to be very dilute, so that the viscosity of the solute plays no great part, and, further, the Einstein formula supposes the molecules of the solute to be large in comparison with those of the solvent. The author has investigated the viscosity and diffusion of solutions of glycerol and bromoform, the solvents, with viscosities varying from 0·25 to 4·45, being

ether, benzene, acetone and ethyl, methyl, propyl and amyl alcohols. The percentage increases in viscosity produced by solution of glycerol to N-concentration are as follows: Water, 27·5; ethyl alcohol, 47·5; 50 per cent. ethyl alcohol, 21·1; propyl alcohol, 51·2; amyl alcohol, 54·1. These increases are very irregular and bear no simple proportion to the viscosities of the solvents themselves. But with the alcohols, the absolute increases in viscosity are about proportional to the viscosities themselves, although 50 % ethyl alcohol gives approximately the same increase as pure alcohol with less than one-half its viscosity. In the influence of bromoform on the viscosity there is greater regularity: the smaller the viscosity of the solvent itself, the greater is the percentage increase of the viscosity on addition of bromoform. The percentage increases for N-concentration of the solute are: Ether, 35; acetone, 24; methyl alcohol, 17; benzene, 13; ethyl alcohol, 9; propyl alcohol, 1·4; amyl alcohol, —9·3. As the viscosities of the solutions, in comparison with those of the components, indicate an additive relation, the bromoform probably occurs in these as single free molecules and does not influence the association factors of the various solvents. The results of the diffusion measurements indicate that neither with glycerol nor with bromoform does $k\eta$ remain constant with different solvents. The solutions used were certainly fairly concentrated, but the numerical results do not seem to indicate constant limiting values. The various factors disregarded by the Einstein formula are discussed.

T. H. P.

1101. *Condensation of Water-vapour in Presence of Nitrogen Oxides and Hydrogen Peroxide, etc.* **W. Bieber.** (Ann. d. Physik, 39. 6. pp. 1313–1337, Dec. 23, 1912. From Dissertation, Marburg, April 29, 1911 and Marburg Naturforschenden Gesell., Dec., 1911.)—In connection with the action of oxides of nitrogen in inducing the condensation of water-vapour [see Pringal, Abstract No. 2045 (1908)], the author has made experiments which show that stable ozone, even under the influence of light, is not able to oxidise free nitrogen. According to Barkow [see Abstract No. 1477 (1907)] and to Pringal, the formation of a blue fog depends on the production of oxides of nitrogen, but the author finds that this may occur in oxygen free from nitrogen. The experiments also confirm Wilson's view [see Abstract No. 1025 (1900)] that hydrogen peroxide exists in solution in the blue fog. The possible modes of formation of the peroxide are discussed. Atmospheric hydrogen peroxide undoubtedly owes its existence largely to the action of ultra-violet rays, which liberate oxygen atoms; the latter not only give the peroxide, but also oxidise the ammonia of the air first to hydroxylamine and subsequently to ammonium nitrite. The blue colour of the sky is regarded as due to the presence, in the upper strata of the atmosphere, of small solid particles of ammonium nitrite or nitrate, which scatter the more highly refractive rays to a greater degree than the others; the cause of the variations in the tint must be sought in the varying turbidity of the lower layers of the atmosphere. That such particles do not continually increase in number is due to the establishment of an equilibrium.

T. H. P.

1102. *Electrical Conductance of Non-aqueous Solutions.* **L. I. Shaw.** (Journ. Phys. Chem. 17. pp. 162–176, Feb., 1913.)—Walden's investigation of solutions of tetraethyl-ammonium iodide in a number of organic solvents of different chemical types showed that the dissociating power of the solvent increases with its dielectric constant. In order to ascertain if other solutes

act in an analogous manner to the above iodide, the author has examined qualitatively the conductivity of a number of inorganic salts in methyl alcohol, salicylaldehyde, benzaldehyde, acetic anhydride, acetyl chloride, ethyl acetate, dimethyl sulphate, benzonitrile, acetone, aniline and epichlorhydrin. Among other results it is found no relation is evident between the dissociating power of a solvent and its dielectric constant, extent of association or its chemical unsaturation. Quantitative conductivity measurements were made on solutions of mercuric chloride and iodine in epichlorhydrin and of mercuric and lithium chlorides and iodine in acetone. In none of these cases does the molecular conductivity exhibit a limiting value on dilution, but increases steadily even at very high dilutions. Consequently the degree of dissociation at any given dilution cannot be found by dividing the conductivity at that dilution by the conductivity at infinite dilution. With a solution of lithium chloride in acetone, the molecular conductivity at first increases, then decreases and finally increases again with progressive dilution. The fact that the author has prepared epichlorhydrin and acetone with conductivities lower than the minimum values attainable by Walden seems to indicate that these solvents conduct, not by reason of "self-dissociation" but owing to the presence of constant impurities. T. H. P.

1103. *Electrical and Chemical Effects of the Explosion of Azoimide.* **P. J. Kirkby** and **J. E. Marsh.** (Roy. Soc., Proc. Ser. A. 88. pp. 90–99, Feb. 24, 1913.)—The HN_3 is prepared by letting sulphuric acid decompose BaN_6, and by sucking the dried HN_3 into a receiver and an explosion chamber, the annular space between two gilded brass cylinders, one of which is joined to one of the Oxford electric mains (about 105 volts), and the other to a low-resistance ballistic galvanometer (d'Arsonval); the Pt-wires for exploding the gas are inserted in the tubular connection of the chamber with the glass apparatus. The explosion chamber is exhausted; the gas is then admitted and exploded, and the throw of the galvanometer determined; "a series of experiments is carried out continuously upon the same sample of gas." The number of pairs of ions generated by an explosion of azoimide, it is said, is exceedingly small (less than 1 in 100,000) compared with the number of molecules dissociated by the explosion. The numbers were irregular, however, one of the explosions (sometimes the first, sometimes another of a series) giving many times (7) more electricity than another; the results varied also when the polarity of the two cylinders was exchanged or resistance introduced into the circuit. The lowest gas pressure observed at which explosion took place was 11 mm., whilst in previous experiments with electrolytic gas [see Abstract No. 3258 (1904)] the minimum was 80 mm. The brass cylinders had been gilded to prevent action of the azoimide on the copper; yet a small amount of a crystalline deposit, apparently of cupric azoimide, was observed at the end of a series; this cupric azoimide is supposed to have been formed during the actual explosions, not before them. H. B.

1104. *Charged Surface Layers in Contact-Potential Phenomena between Metals.* **A. N. Shaw.** (Phil. Mag. 25. pp. 241–256, Feb., 1913. Electrician, 71. pp. 25–26, April 11, 1913. Abstract.)—The author describes ionisation methods for measuring contact potentials between metallic plates, and shows that they give reliable results. Investigation of the rate of charging due to contact potential in the case of an insulated plate in ionised gas leads to new direct evidence of the presence of charged surface layers. The time necessary for the formation and charge of these layers is found to be measur-

able, and effects due to their capacity are detectable. Their behaviour agrees with the conception that contact-potential phenomena can be explained by the different amounts of work done by electrons in escaping from different metals. The rate of charging or removal of the layers responsible for contact potential is shown to be independent apparently of the metal and identical with the behaviour of ordinary charges imparted by external means. The influence of the dryness of the gaseous medium and the nature of the gas on the formation of these charged layers has been investigated, and it would appear that, although chemical action may cause large contact effects, it is not usually responsible for more than a small part of the phenomenon.

T. H. P.

1105. *Ionisation and the Law of Mass Action.* **W. R. Bousfield.** (Chem. Soc., Journ. 103. pp. 307–317, Feb., 1913.)—At very great dilutions the coefficient of ionisation of a dissolved salt becomes substantially equal to unity. There is therefore, then, no real difference between any of the following five dilution formulæ :—

Rudolphi ..... $\frac{a^2}{1-a} = \frac{h^4}{5{\cdot}37}$ New relation ..... $\frac{a}{1-a} = \frac{h^4}{5{\cdot}37}$

Van't Hoff..... $\frac{a^3}{1-a} = \frac{h^4}{5{\cdot}37}$ Kohlrausch..... $\frac{a^n}{1-a} = \frac{h^4}{5{\cdot}37}$

Limiting relation..... $\frac{1}{1-a} = \frac{h^4}{5{\cdot}37}$

where h is the number of mols. of water per mol. of solute. All of these may be applied equally well to interpret the conductivity data for potassium chloride, but all agree in giving the coefficient 0·5 to h at infinite dilution. They may therefore all be reduced to the simple formula $(1-a) = h^{-\frac{1}{2}} \times$ const. whilst in the same region of great dilution Ostwald's Mass-action Law reduces to $(1-a) = h^{-1} \times$ const. These two formulæ bring out the fundamental difference between the class of "weak" electrolytes, of which acetic acid is an example, and the class of "strong" electrolytes, of which potassium chloride is an example, since for *weak* electrolytes the active mass of the undissociated fraction at great dilution is inversely proportional to the *mass* of the water ; for *strong* electrolytes the active mass of the undissociated fraction at great dilution is inversely proportional to the *square root of the mass* of the water.

T. M. L.

1106. *Mechanism of the Chlorination of Benzene in the Electrolytic Cell.* **R. G. Van Name** and **C. H. Maryott.** (Amer. Journ. Sci. 35. pp. 153–170, Feb., 1913.)—Chlorinations may take place in two ways : by an electrolytic process which is confined to the surface of the anode, and by the secondary action of the dissolved chlorine gas previously liberated by the current. Referring to Zehrlant and to Schleuderberg [see Abstracts Nos. 1157 (1901) and 192 (1909)] the author obtained no positive evidence of any strictly electrolytic chlorination when electrolysing benzene dissolved in glacial acetic acid to which lithium chloride had been added, though the yields rose to 70 per cent. ; the direct treatment of the solution with chlorine gas in the dark directly yielded addition and substitution products as before ; this reaction was not accelerated by simultaneous electrolysis. The addition of benzene to the solvent mentioned raised the anode potential like an addition of carbon-tetrachloride, whilst phenol lowered the potential.

H. B.